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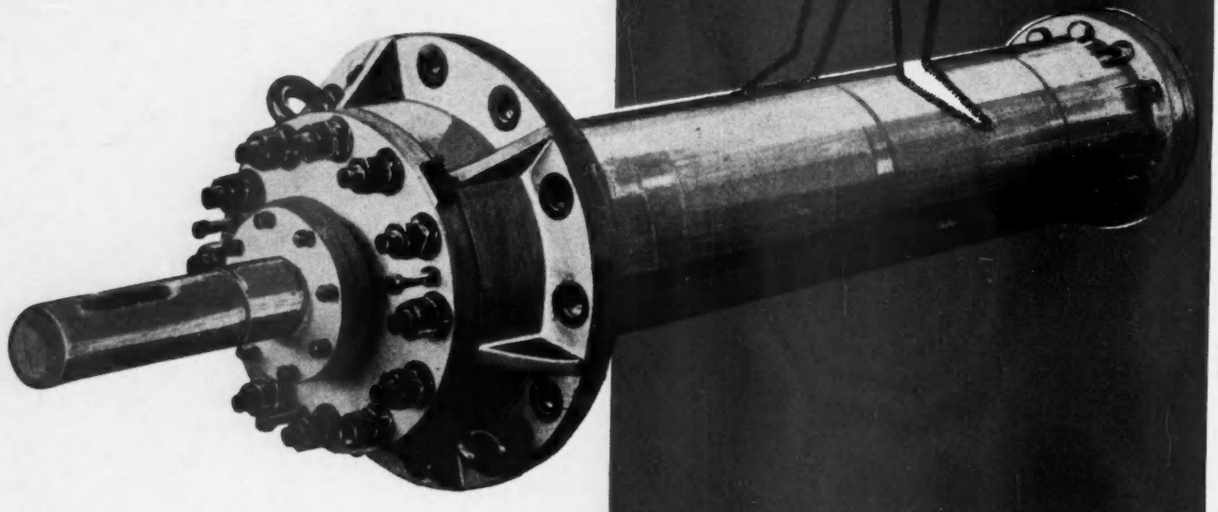

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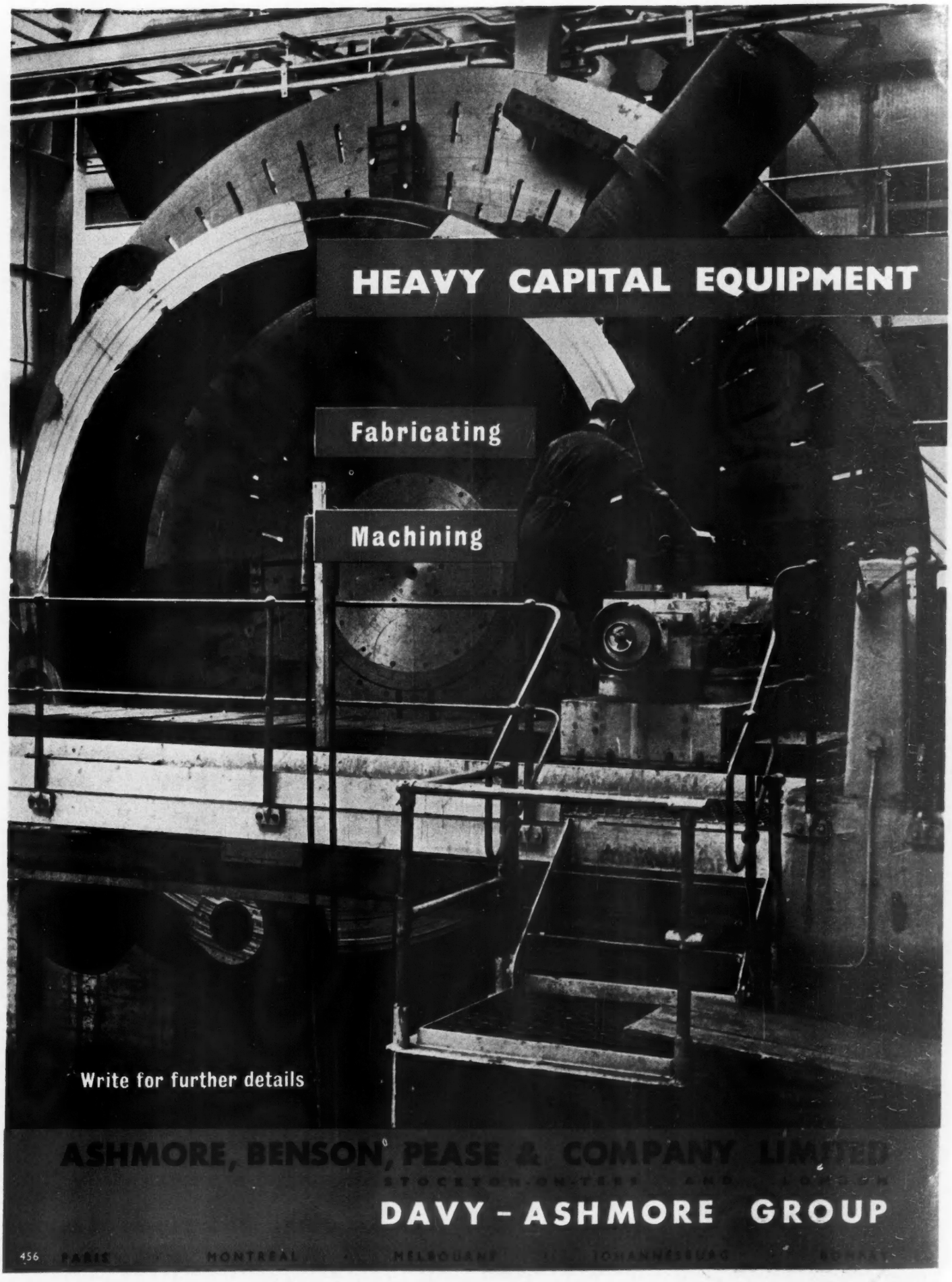
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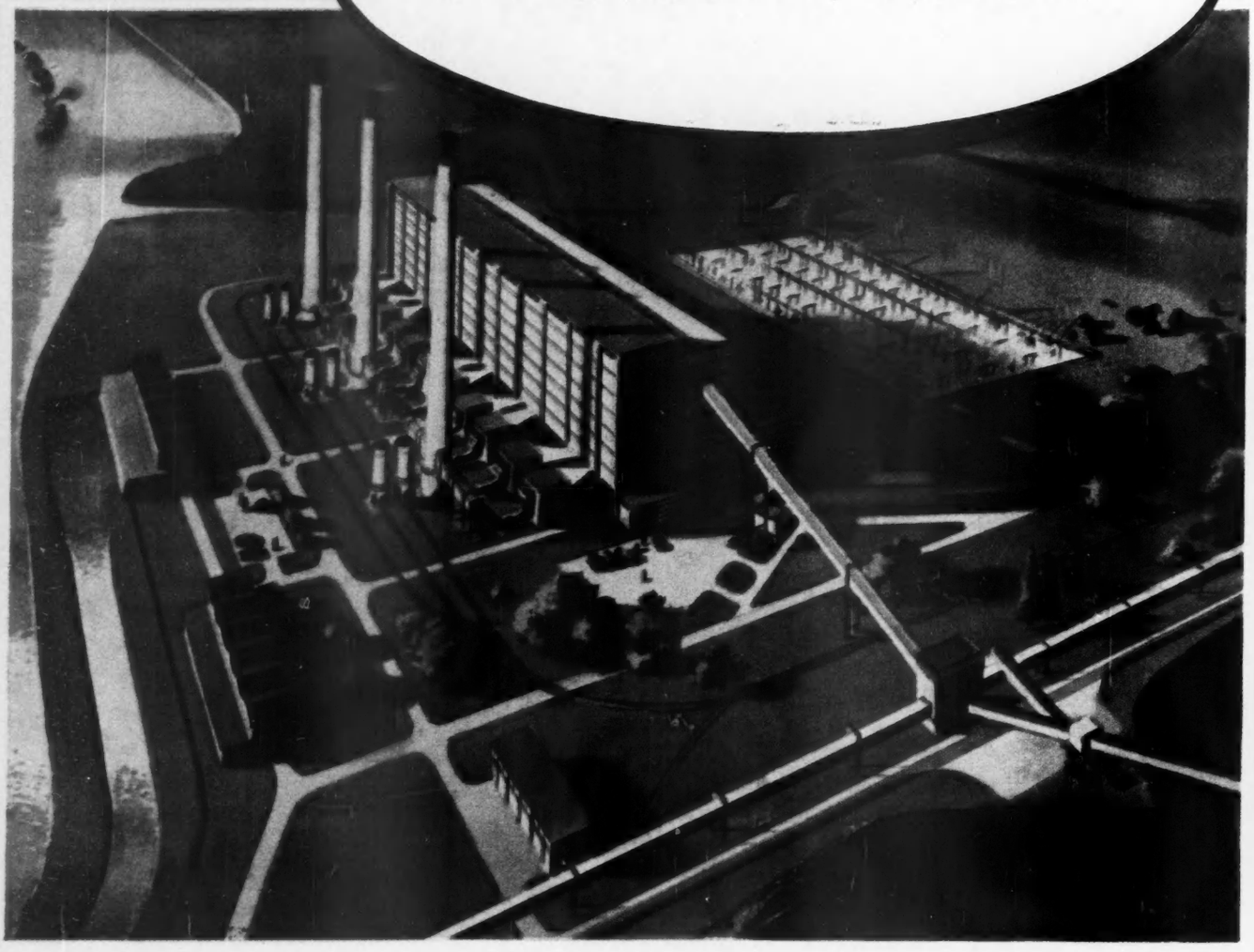

From an original drawing supplied by the Hydro Electric Power Commission of Ontario

THIS artist's impression shows the Lakeview Generating Station now being built beside Lake Ontario. With its planned capacity of 1,800 MW, it will be one of the world's largest thermal-electric plants. Two 300 MW turbine-generators have been ordered from AEI and the first will be installed in 1963. These generating sets, like all AEI equipment, will incorporate advanced design based on long experience.

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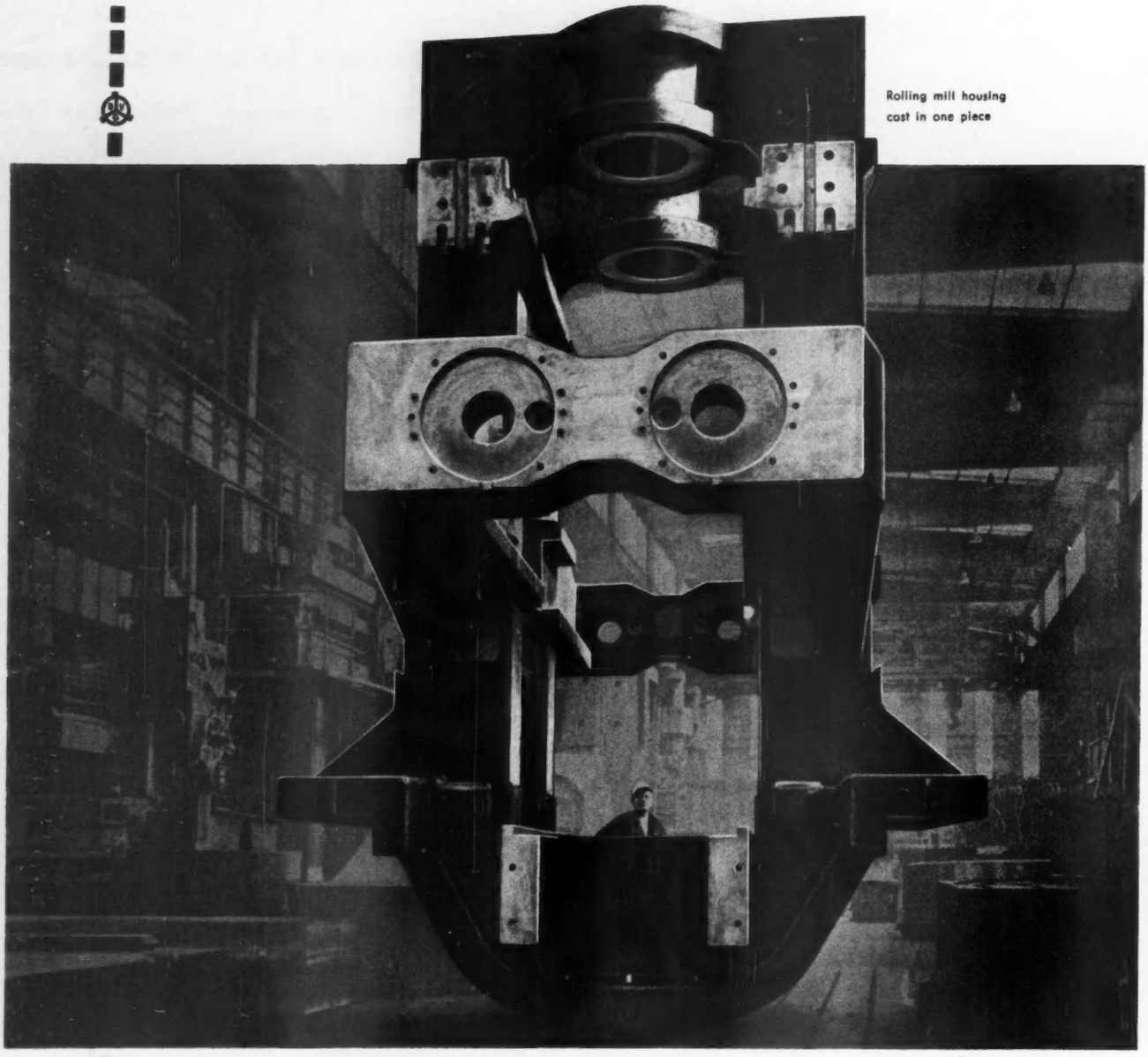

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A machining operation on the front cover of an aircraft gas-turbine. (*Nurnberg photograph for* ENGINEERING)

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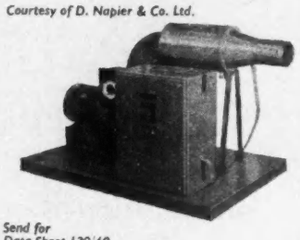

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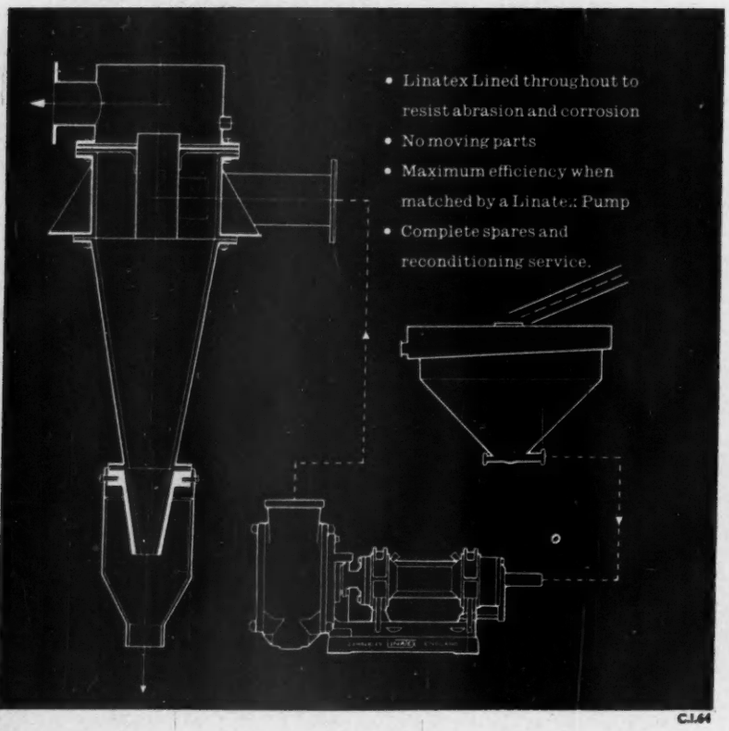

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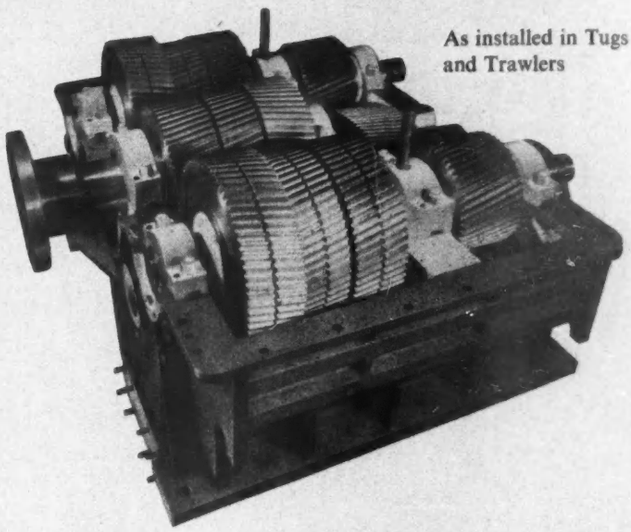

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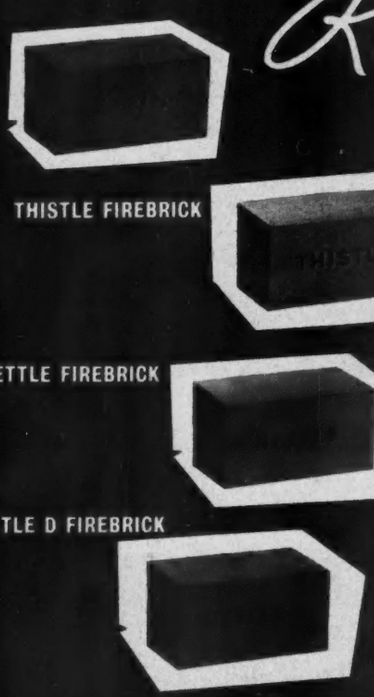

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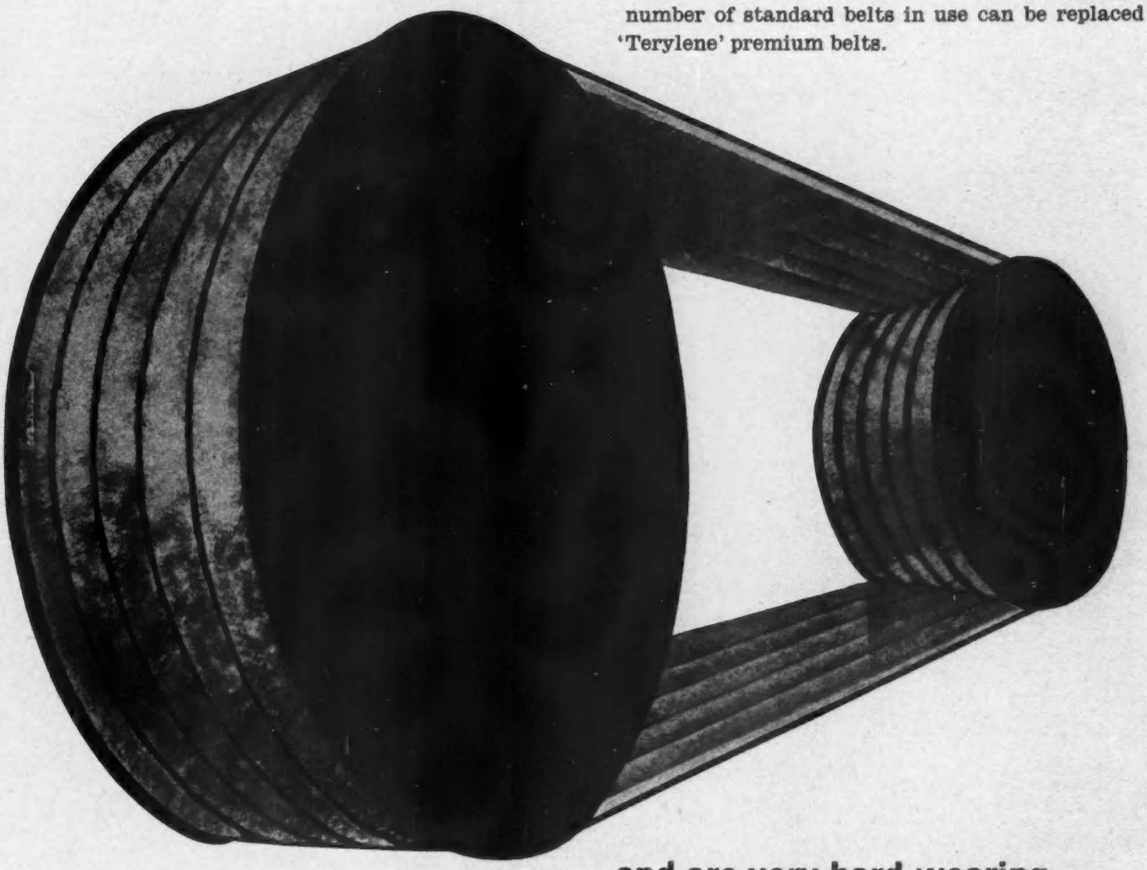

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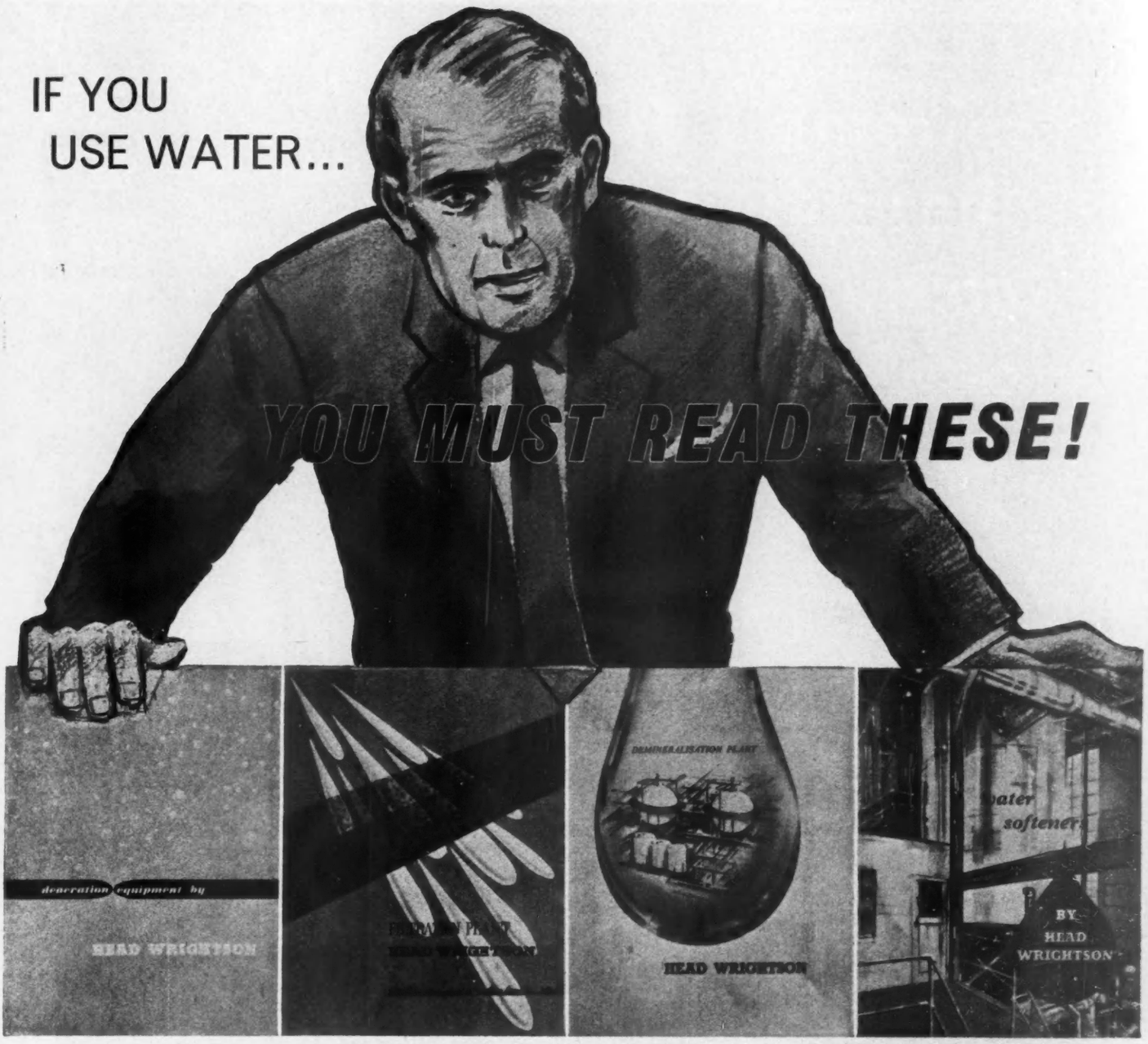

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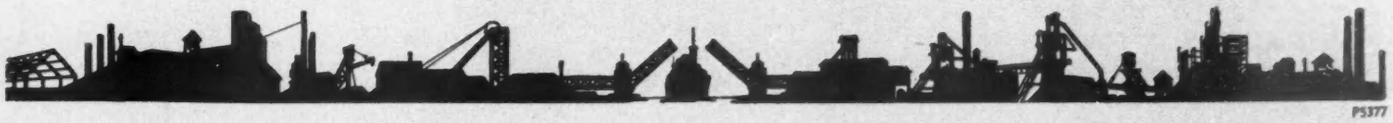

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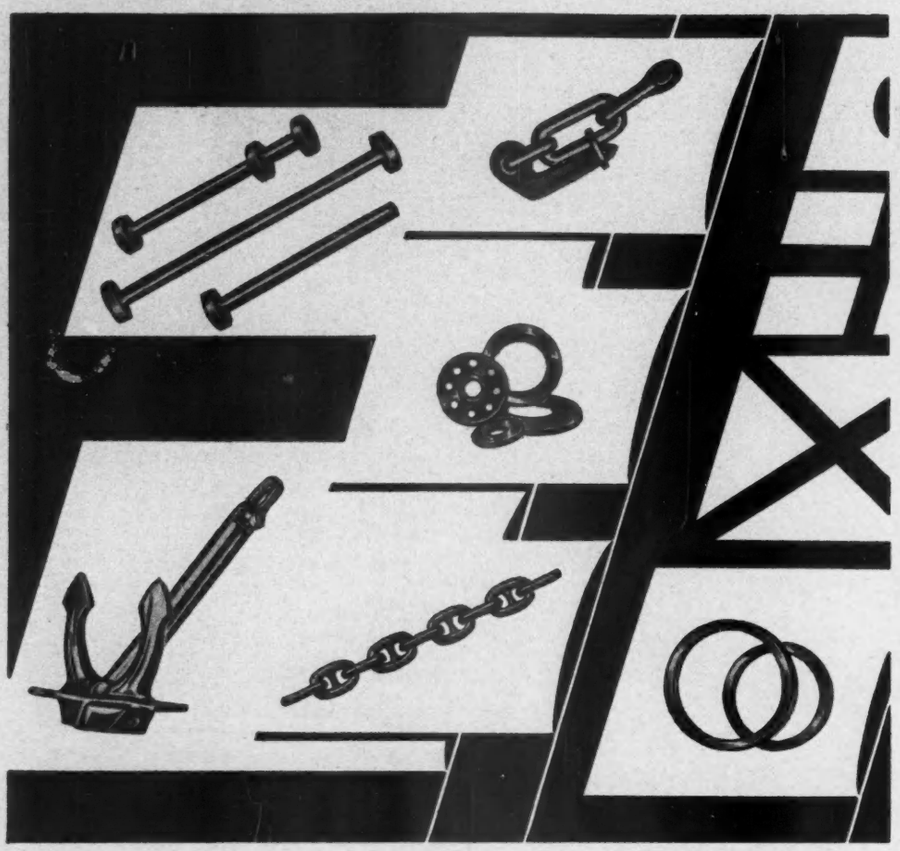

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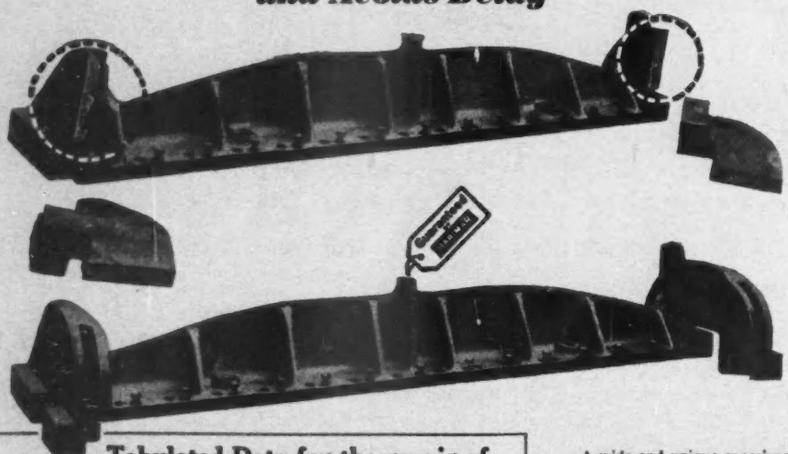
WHEN a Guillotine "Gives up the Ghost!"

BARIMAR Scientific Welding repairs the Breakage, and Avoids Delay



Sturdy they may be, but guillotines and similar machines in industrial use are peculiarly prone to breakdown. Overloads, bad adjustment, blunt knives, unsuitable materials—all these can result in serious fractures in "key" machines which delay production "all along the line".

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ditto	knife holders	Punching	Machine	Bodies
ditto	beams	Stamping	Machine	Bodies

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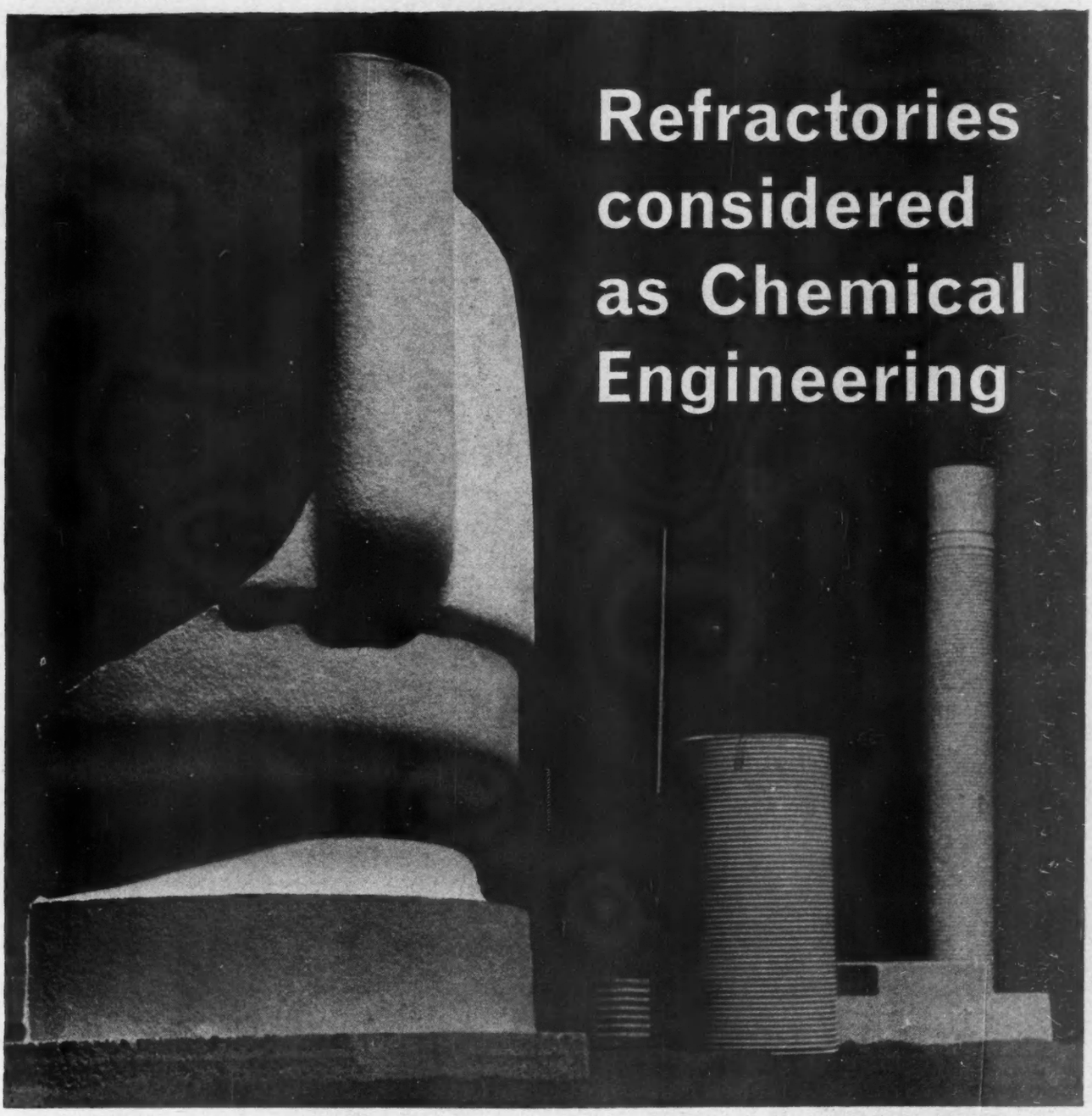

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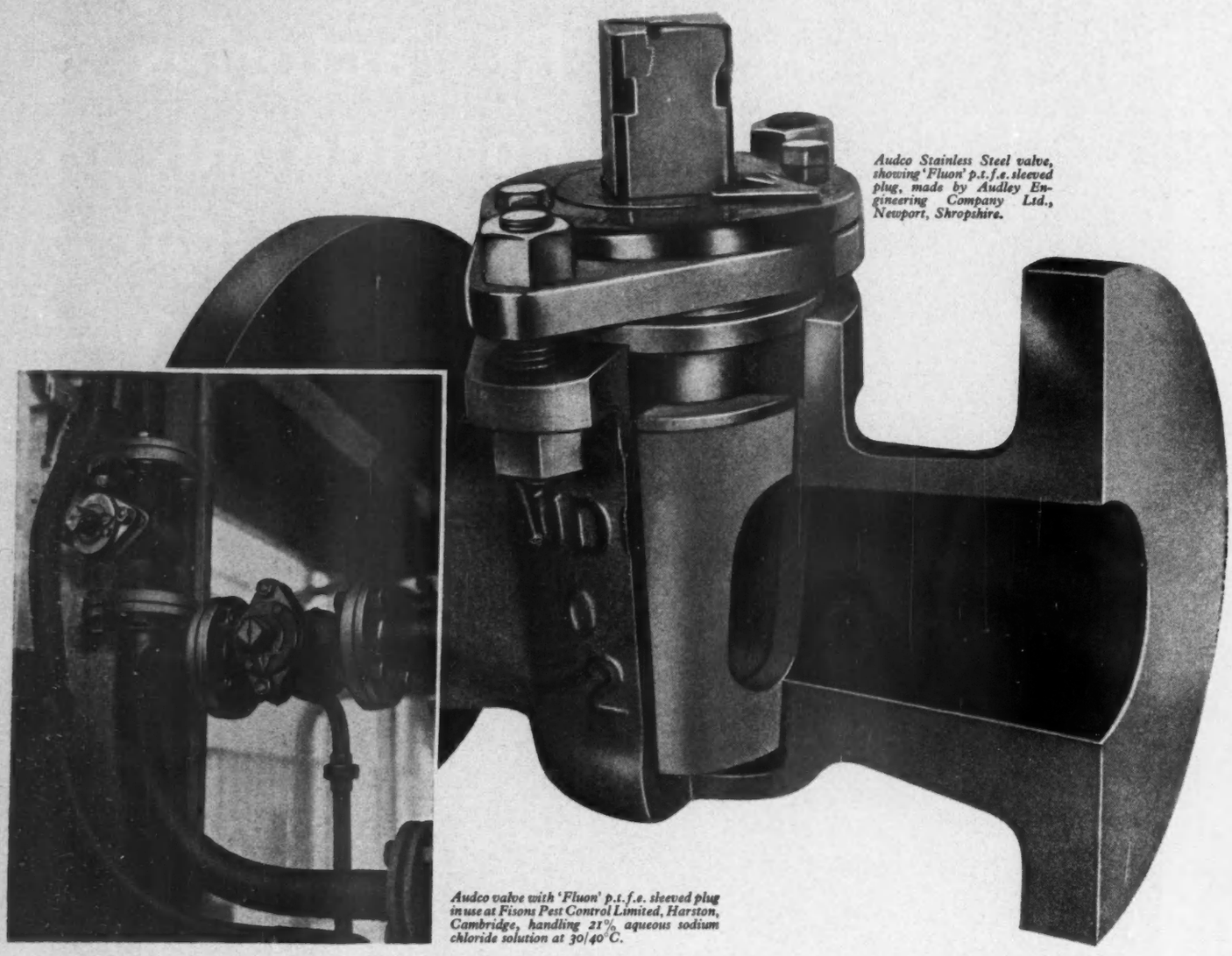


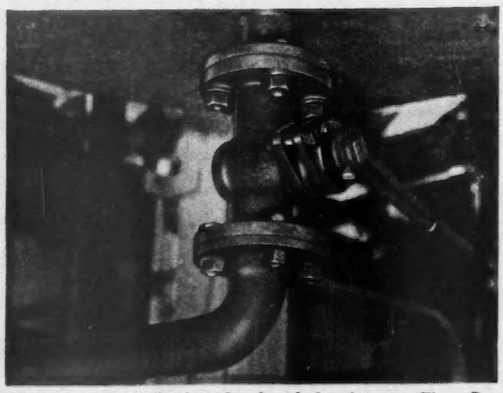
Audco Stainless Steel valve, showing 'Fluon' p.t.f.e. sleeved plug, made by Audley Engineering Company Ltd., Newport, Shropshire.

Audco valve with 'Fluon' p.t.f.e. sleeved plug in use at Fisons Pest Control Limited, Harston, Cambridge, handling 21% aqueous sodium chloride solution at 30/40°C.

Valves with 'Fluon' sleeved plugs handle any chemical without sticking or leaking and need no lubrication

THIS VALVE, made by Audley Engineering Company Ltd., can handle virtually any chemical at pressures up to 150 p.s.i. and temperatures up to 100°C. It requires a remarkably low turning effort, won't stick or gall, and never needs lubrication or any other maintenance. Its secret is that its plug has a thin sleeve of 'Fluon' p.t.f.e. compounded with a suitable inert filler for dimensional stability.

This is only one out of hundreds of products that benefit from the remarkable properties of 'Fluon'. 'Fluon' is an I.C.I. plastic material which is immune to virtually all forms of chemical attack. It has a working temperature from +250°C. down to at least liquid nitrogen temperatures, the best dielectric properties and the lowest coefficients of friction of any solid. It is also both tough and flexible.



Audco valves with 'Fluon' p.t.f.e. sleeved plugs in use at Fisons Pest Control Limited, Harston, Cambridge, handling chlorinated solvent containing ½% anhydrous H.Cl. at 95°C.

'FLUON'

'Fluon' is the registered trade mark for polytetrafluoroethylene manufactured by I.C.I.

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PT 60

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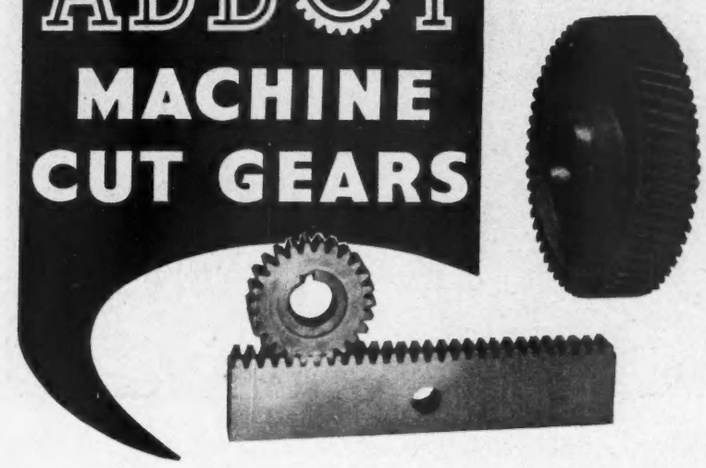

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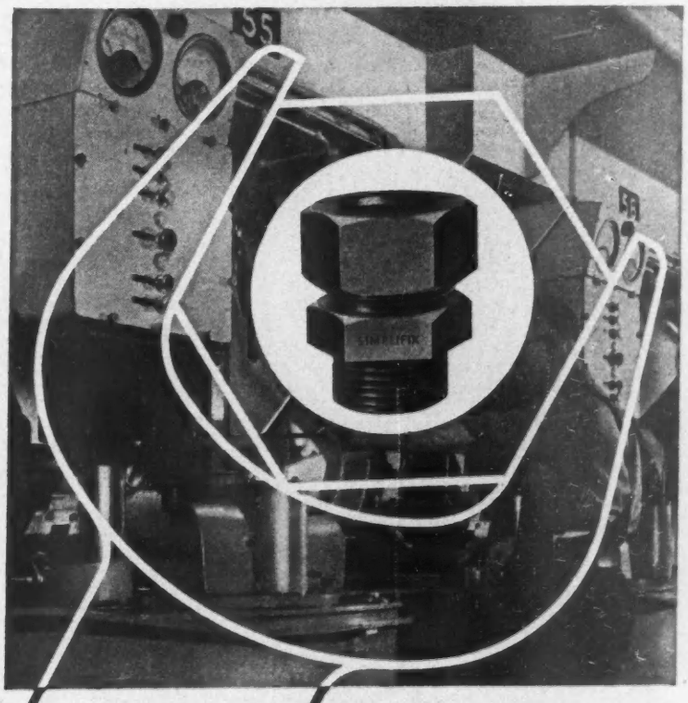

The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.

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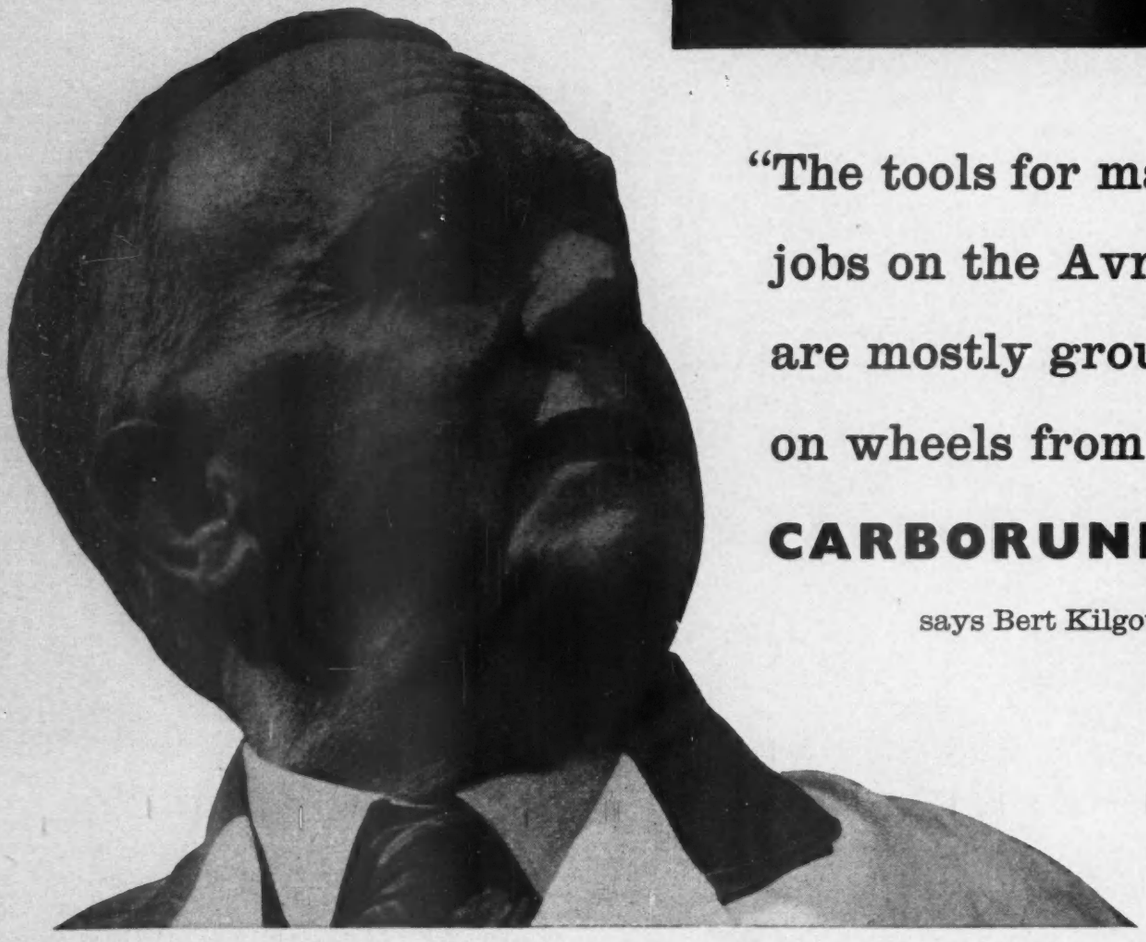

"The tools for machining jobs on the Avro Vulcan are mostly ground on wheels from CARBORUNDUM"

says Bert Kilgour

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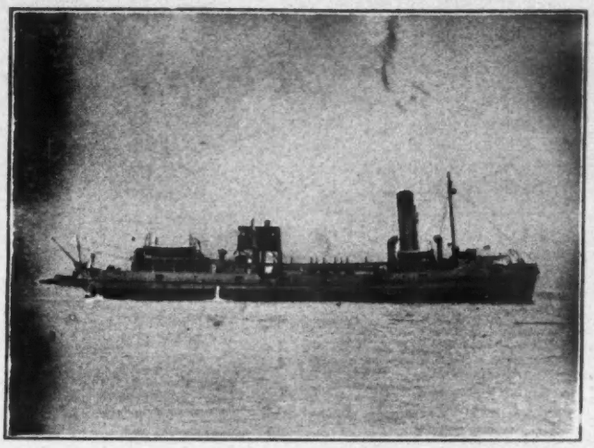

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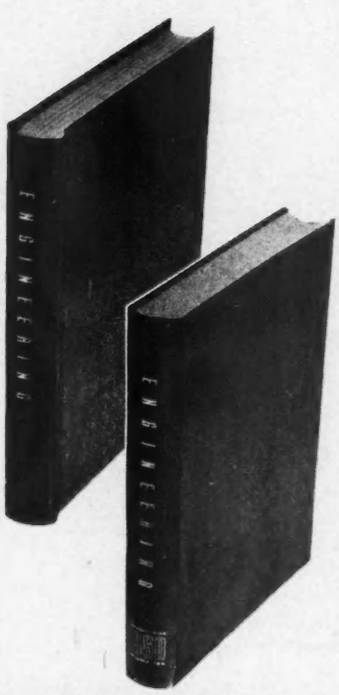

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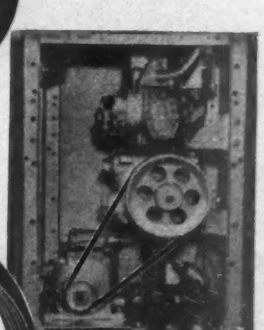

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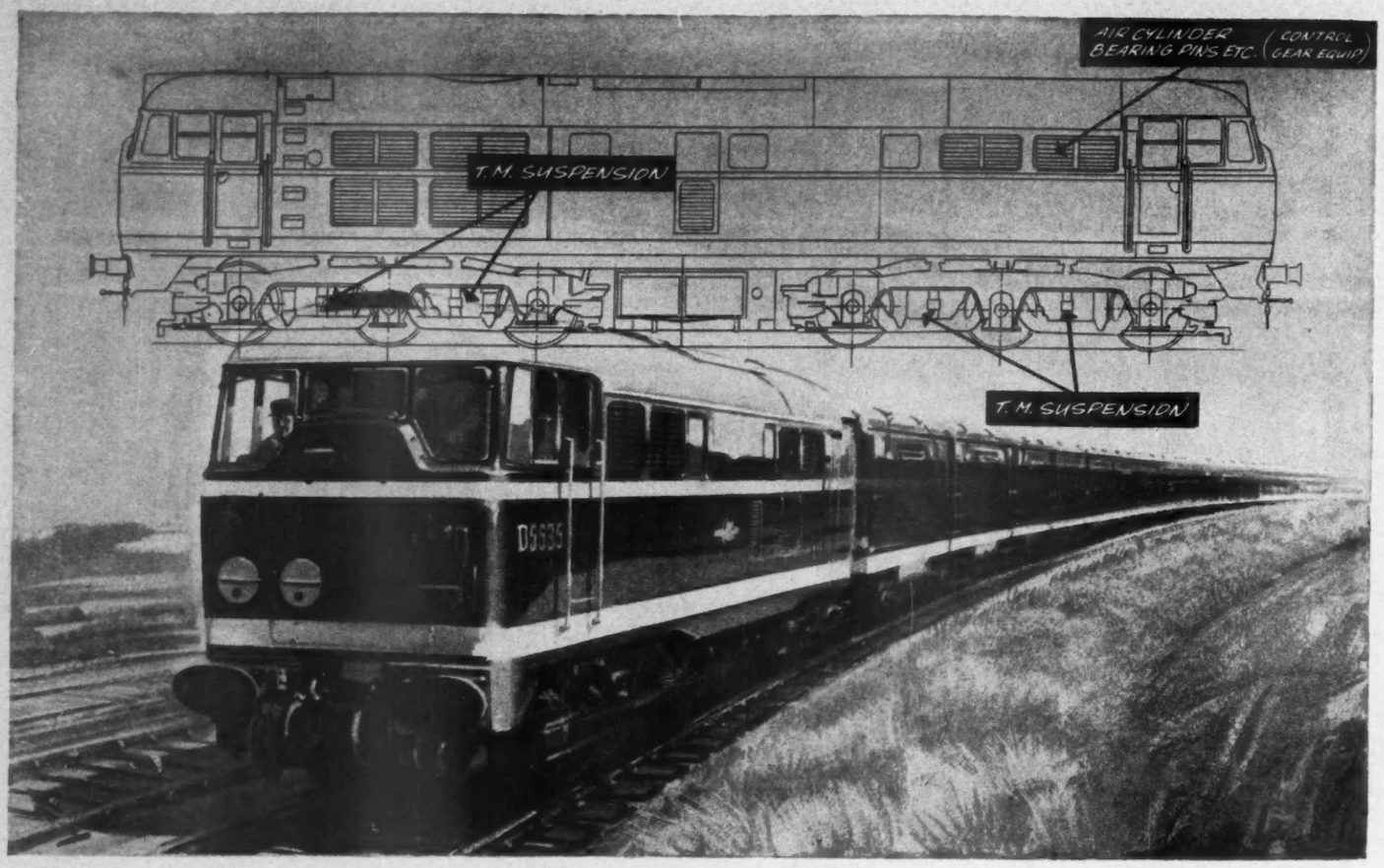

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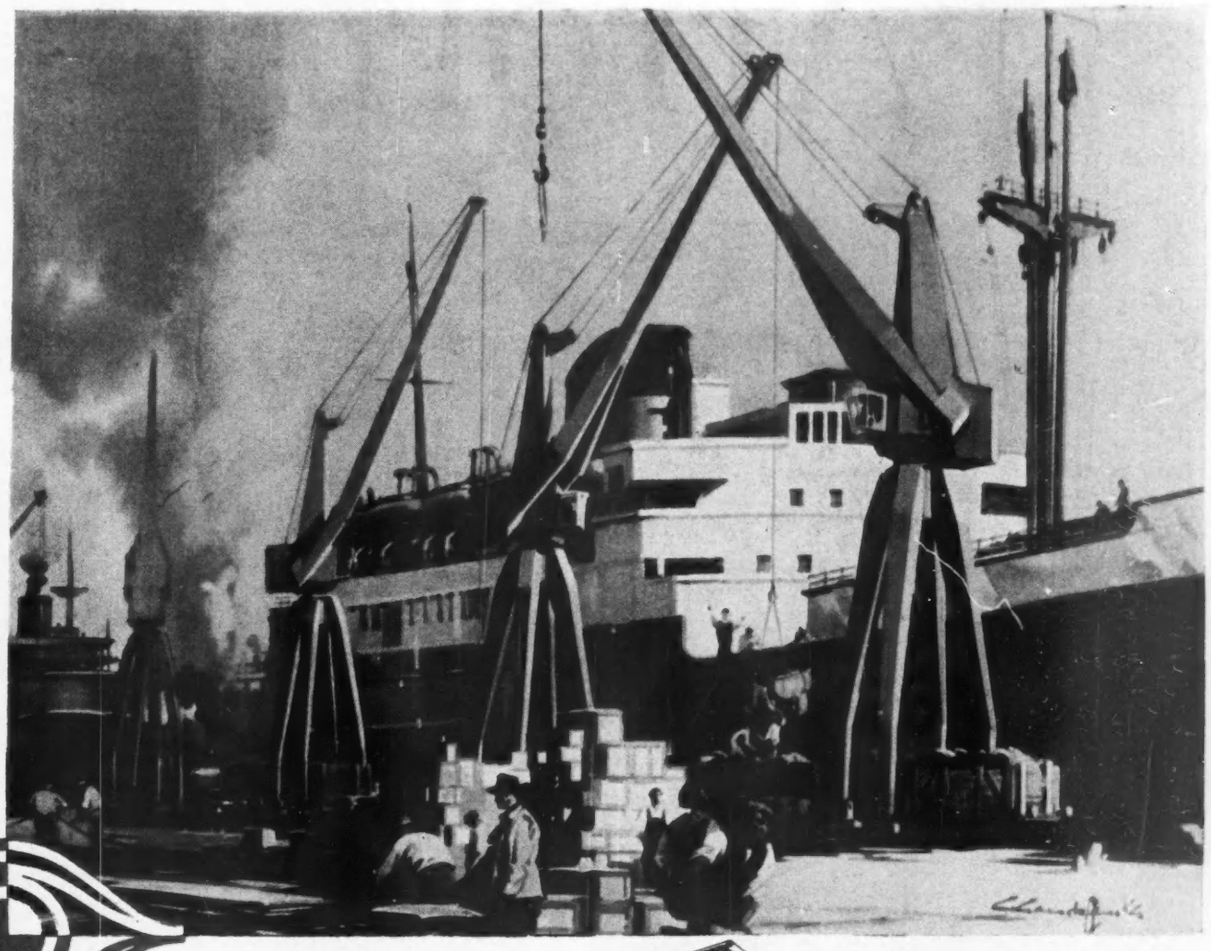
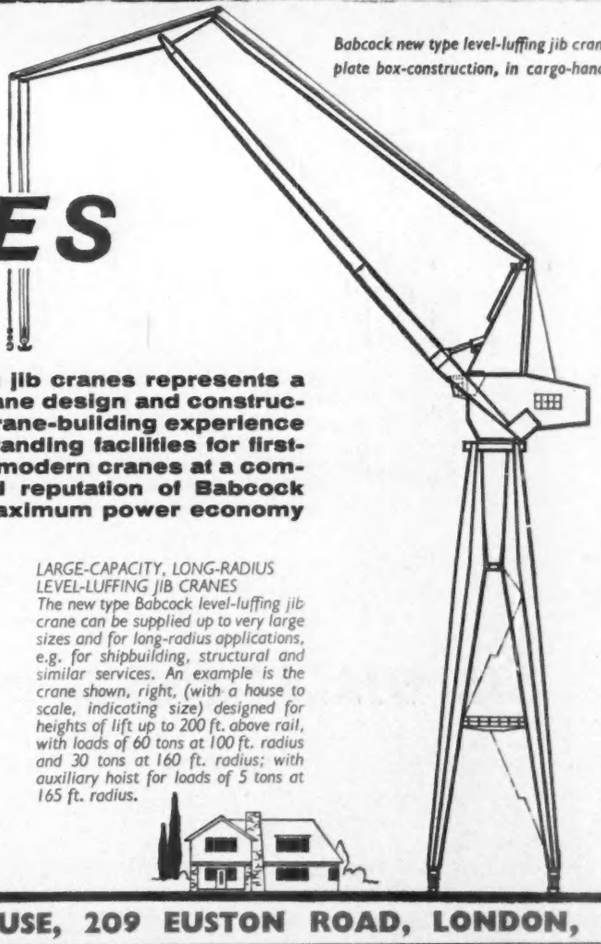


Babcock new type level-luffing jib cranes of welded-plate box-construction, in cargo-handling service.

A new look at CRANES



The new range of BABCOCK level-luffing jib cranes represents a completely fresh approach to modern crane design and construction, taking advantage of over 50 years' crane-building experience and using to the full the Company's outstanding facilities for first-class welded fabrication. These are fine, modern cranes at a competitive price, enhancing the established reputation of Babcock cranes for safe, speedy handling with maximum power economy and minimum maintenance.

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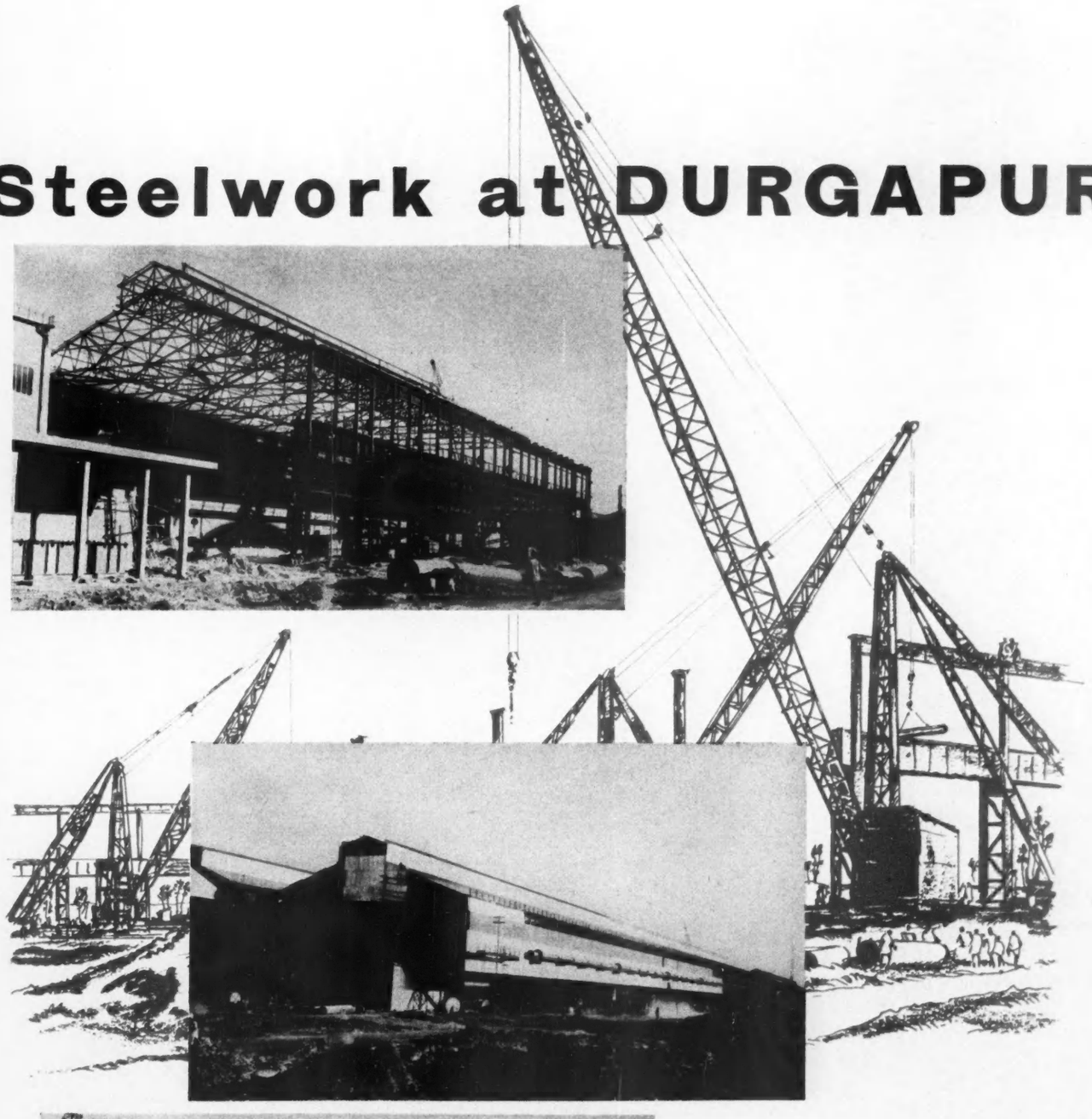

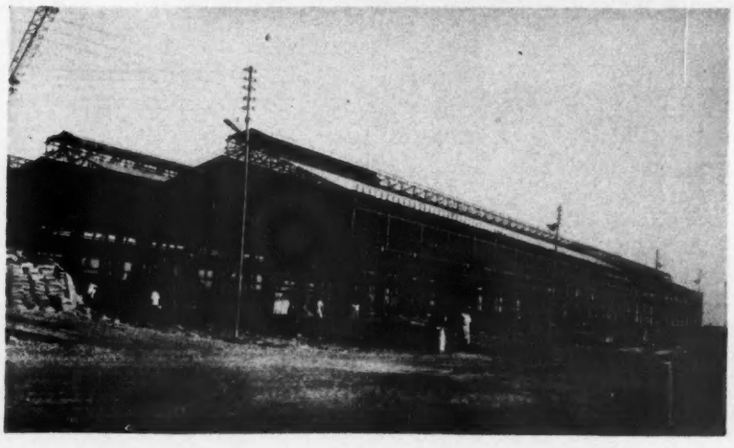

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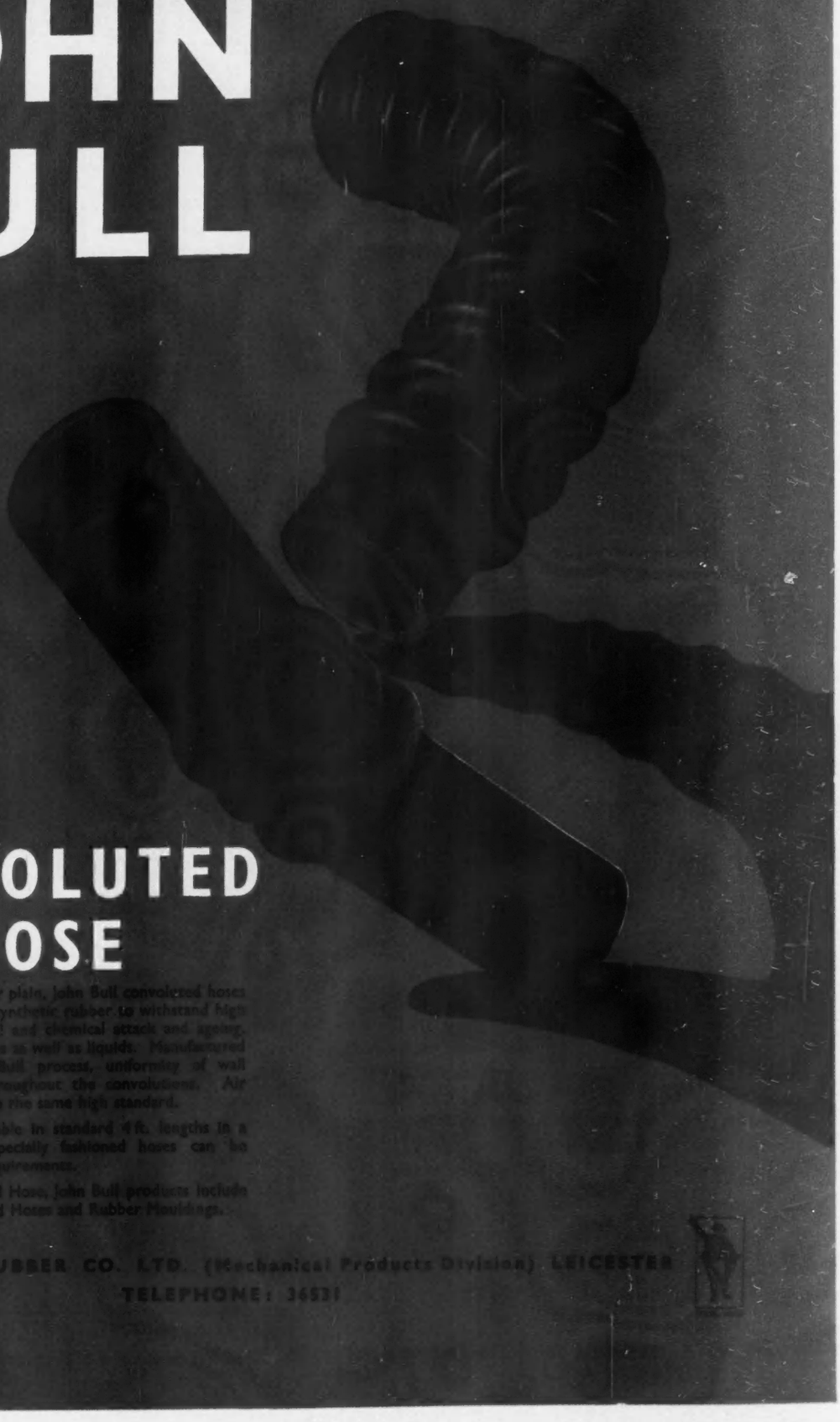

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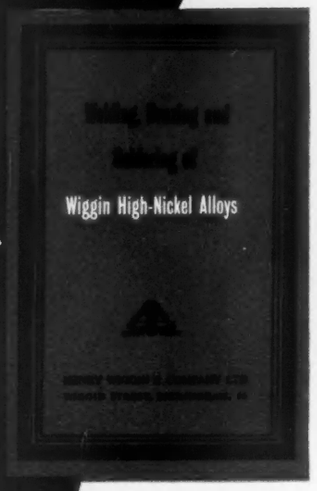

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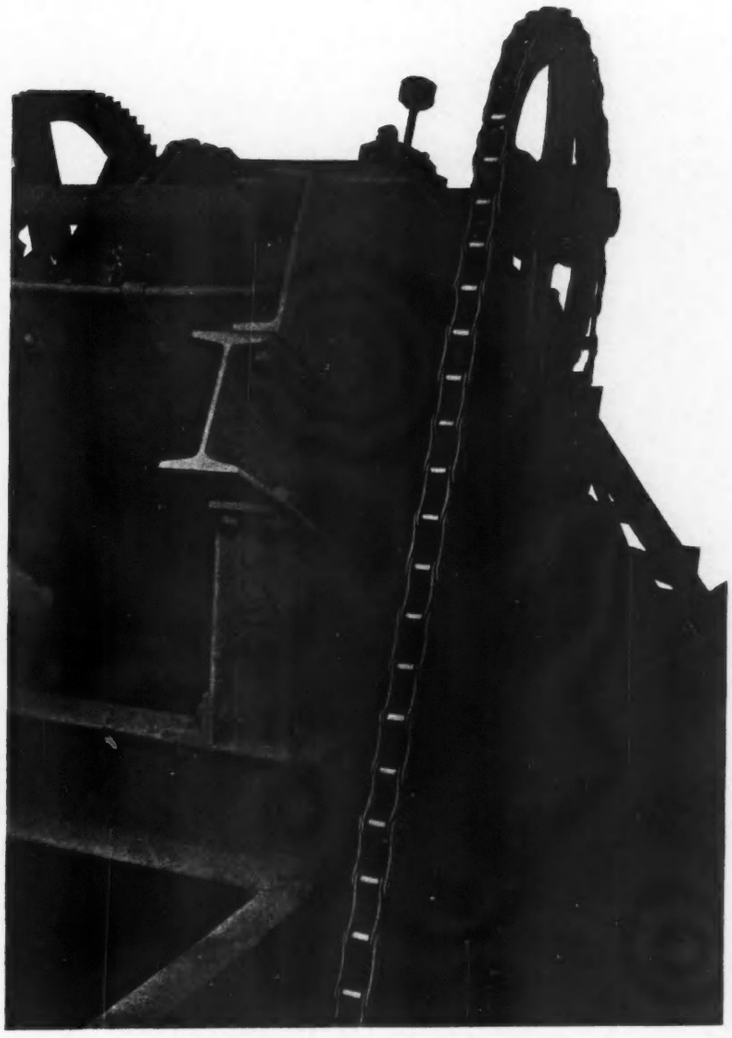

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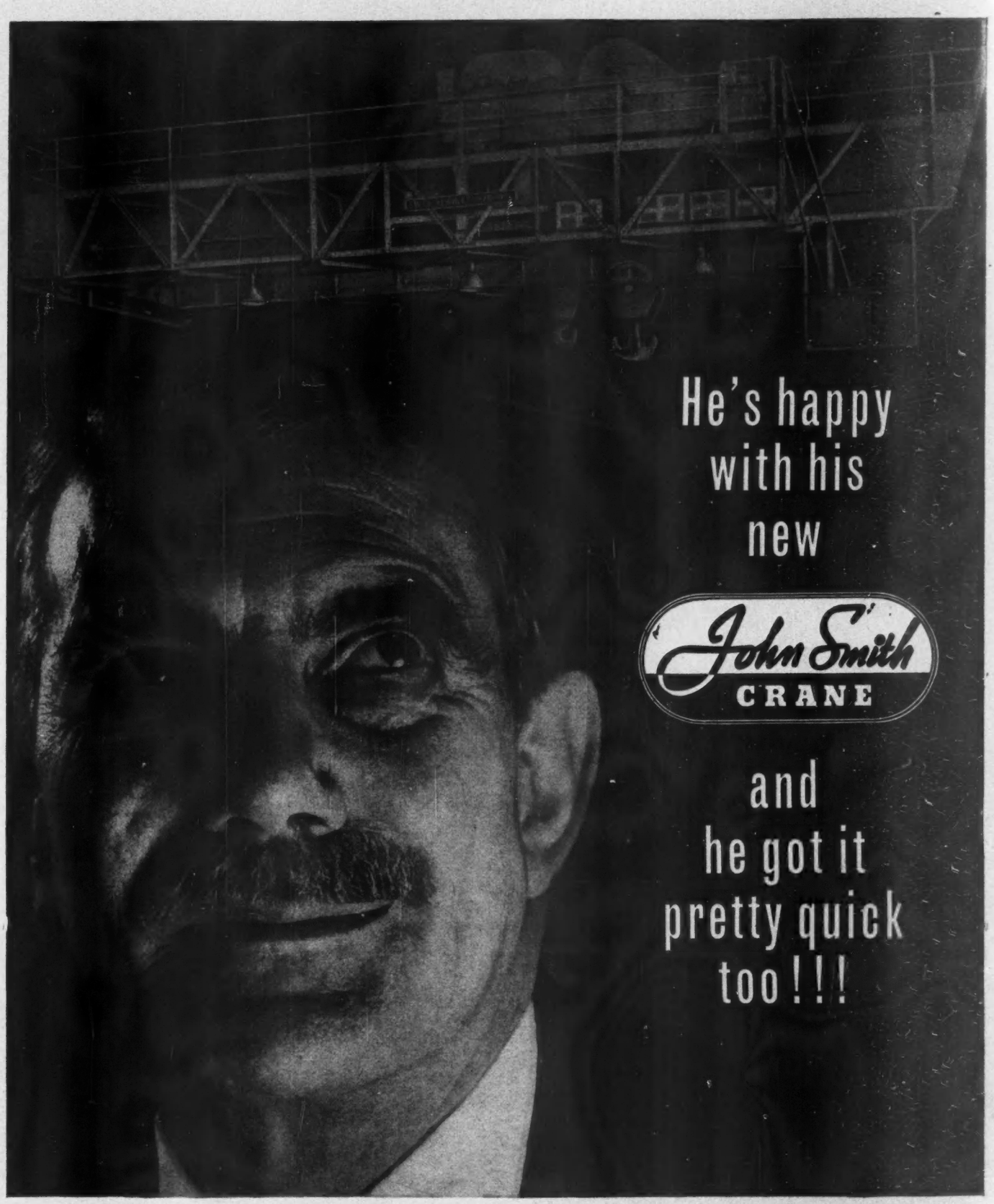

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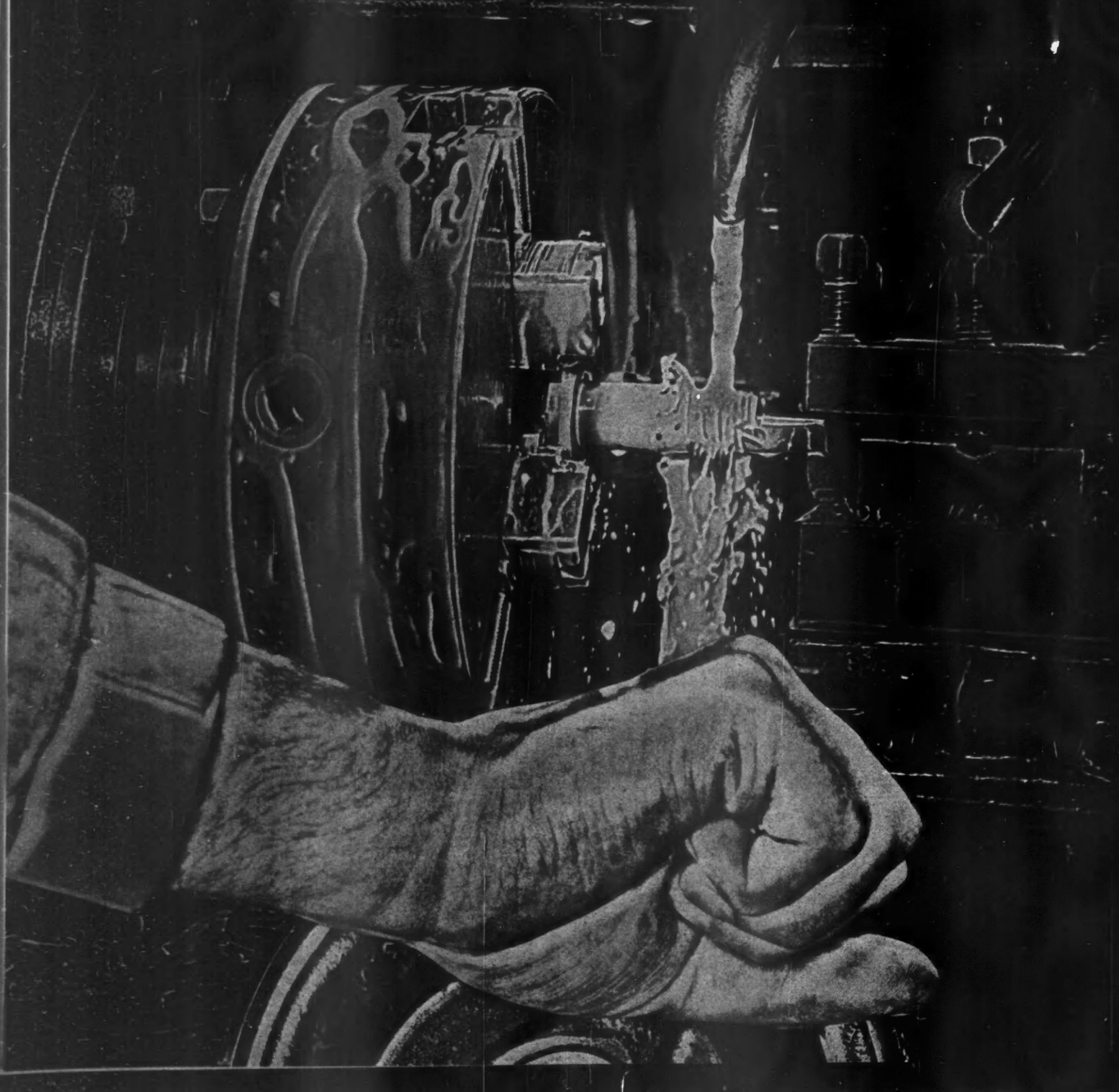


With new Shell Dromus Oils

Most modern soluble cutting oils contain phenolic compounds used as coupling agents between the oil and the emulsifier, for better blending and easier mixing. These phenolic compounds can cause skin irritation, especially where modern high-speed machines are used and the emulsion can concentrate, through the evaporation of water, above the safety level.

Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant. The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

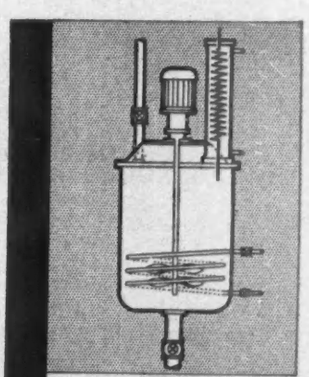
The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

Exhaustive testing of blend stability, emulsion stability, anti-corrosion and machining properties led to selection of the most promising blends. A pilot plant was set up to produce batches of these for use in field trials.

This field testing and final development proceeded for two years whilst production plants were erected at points so chosen as to give the most economical and rapid delivery throughout the United Kingdom.



This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

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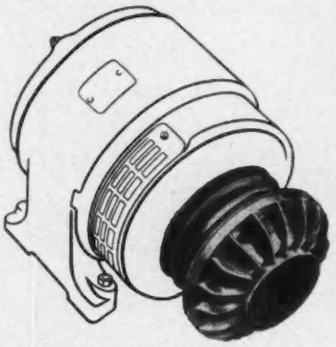

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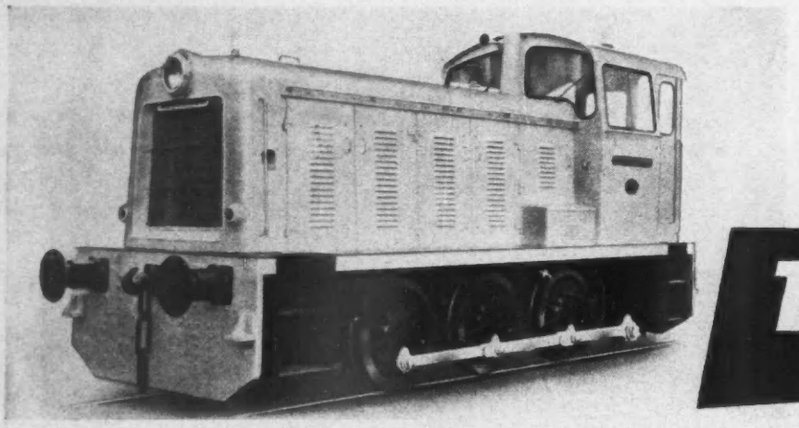

Diesel Mechanical
Wheel arrangement 0-6-0
Dorman 6QA diesel engine 208 H.P. at 1,300 r.p.m.
Weight 33.5 tons
Starting Tractive Effort 17,860 lbs.

Right on the rails with
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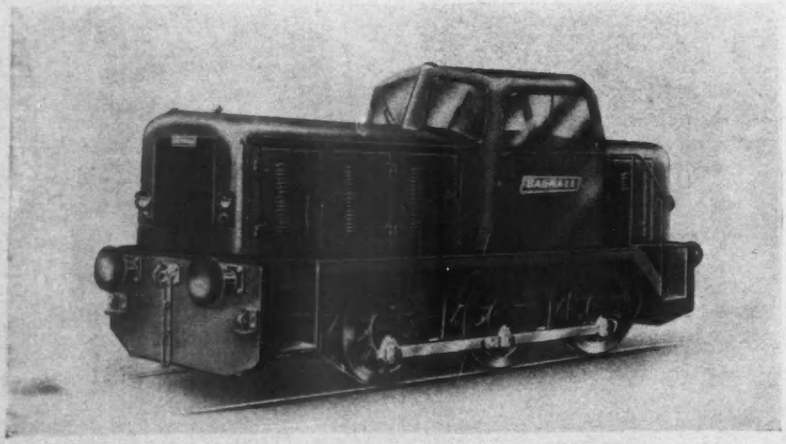

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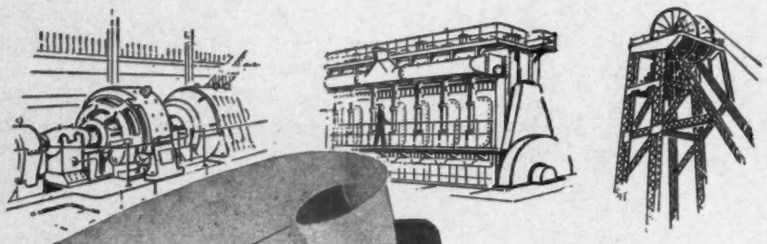

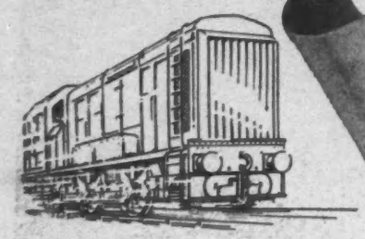

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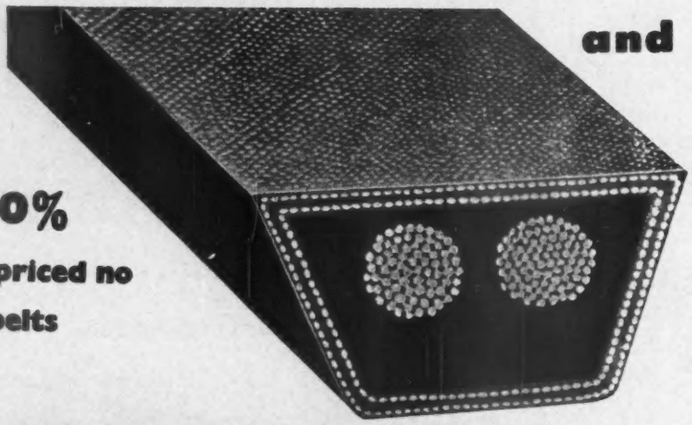

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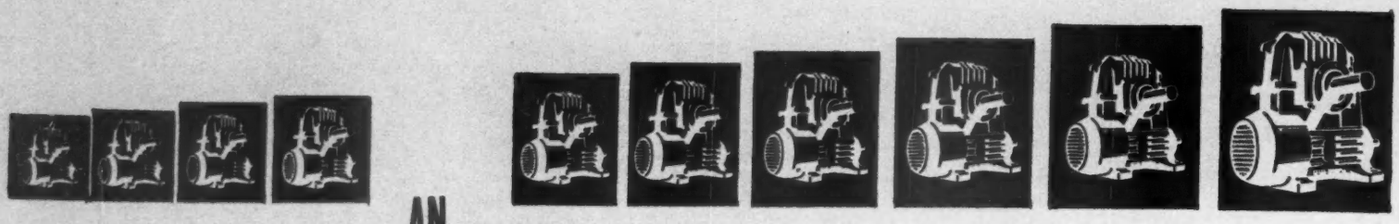

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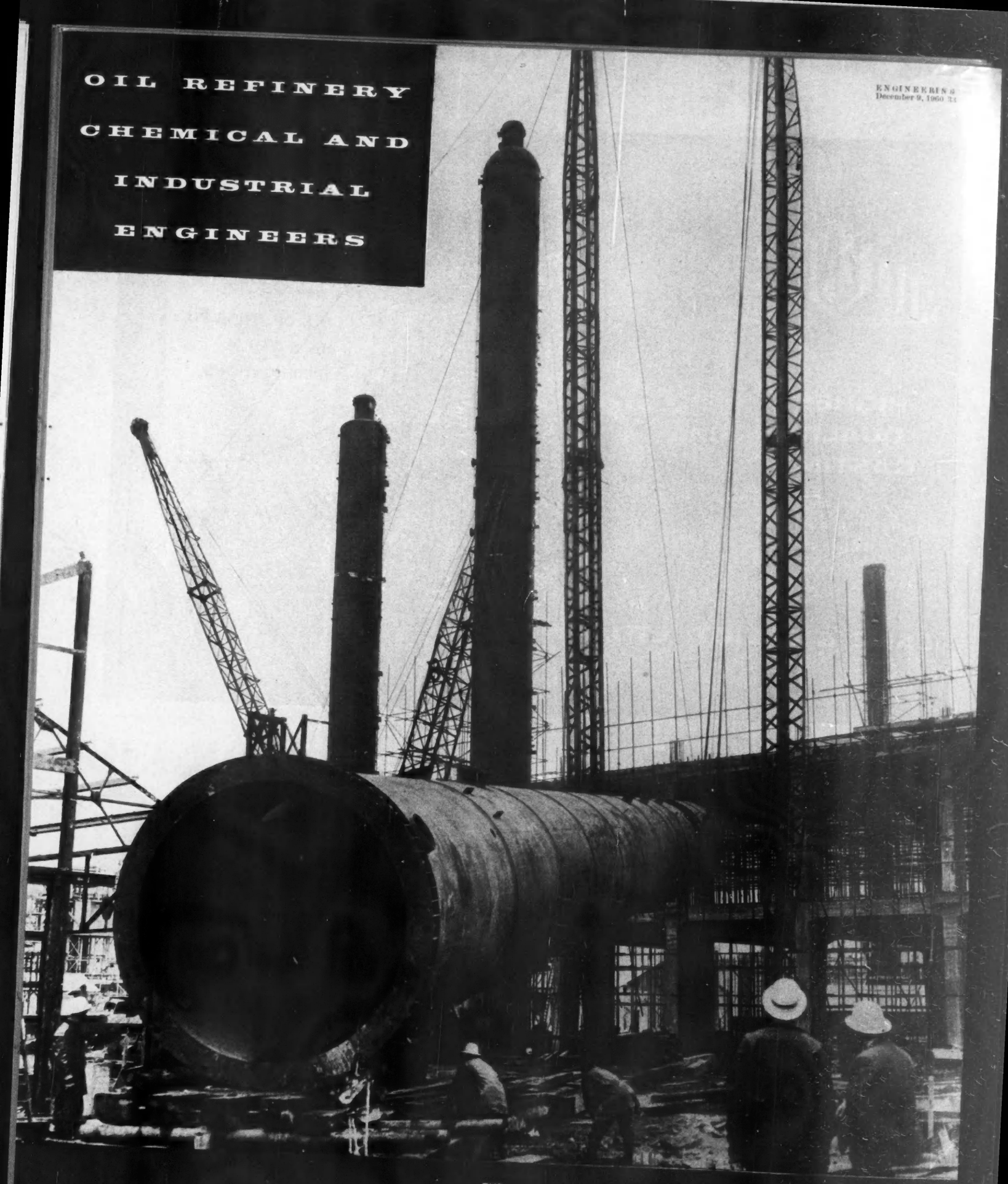

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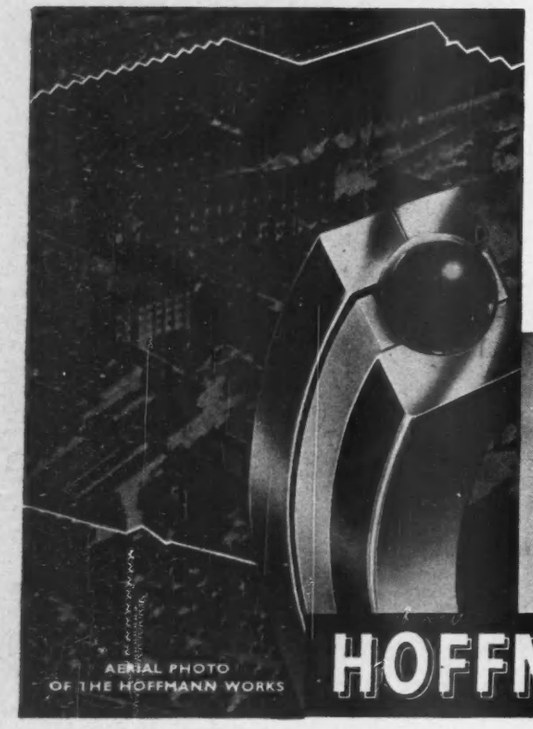
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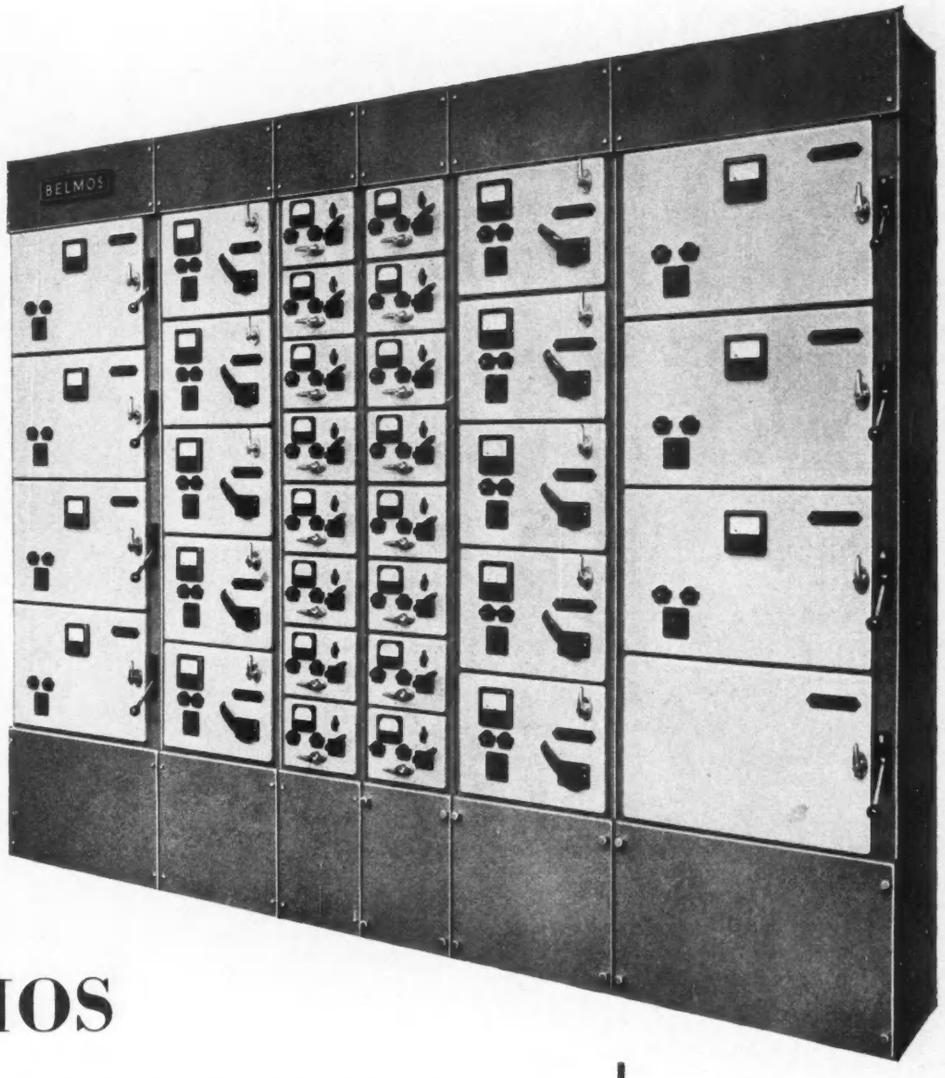

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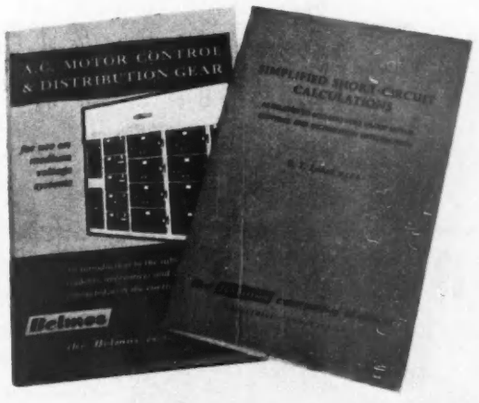

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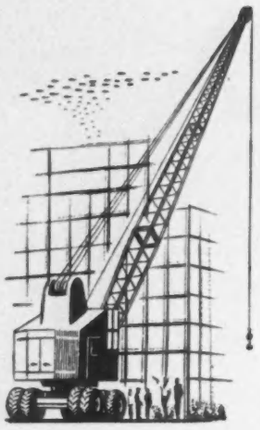

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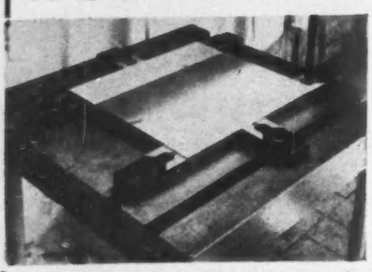

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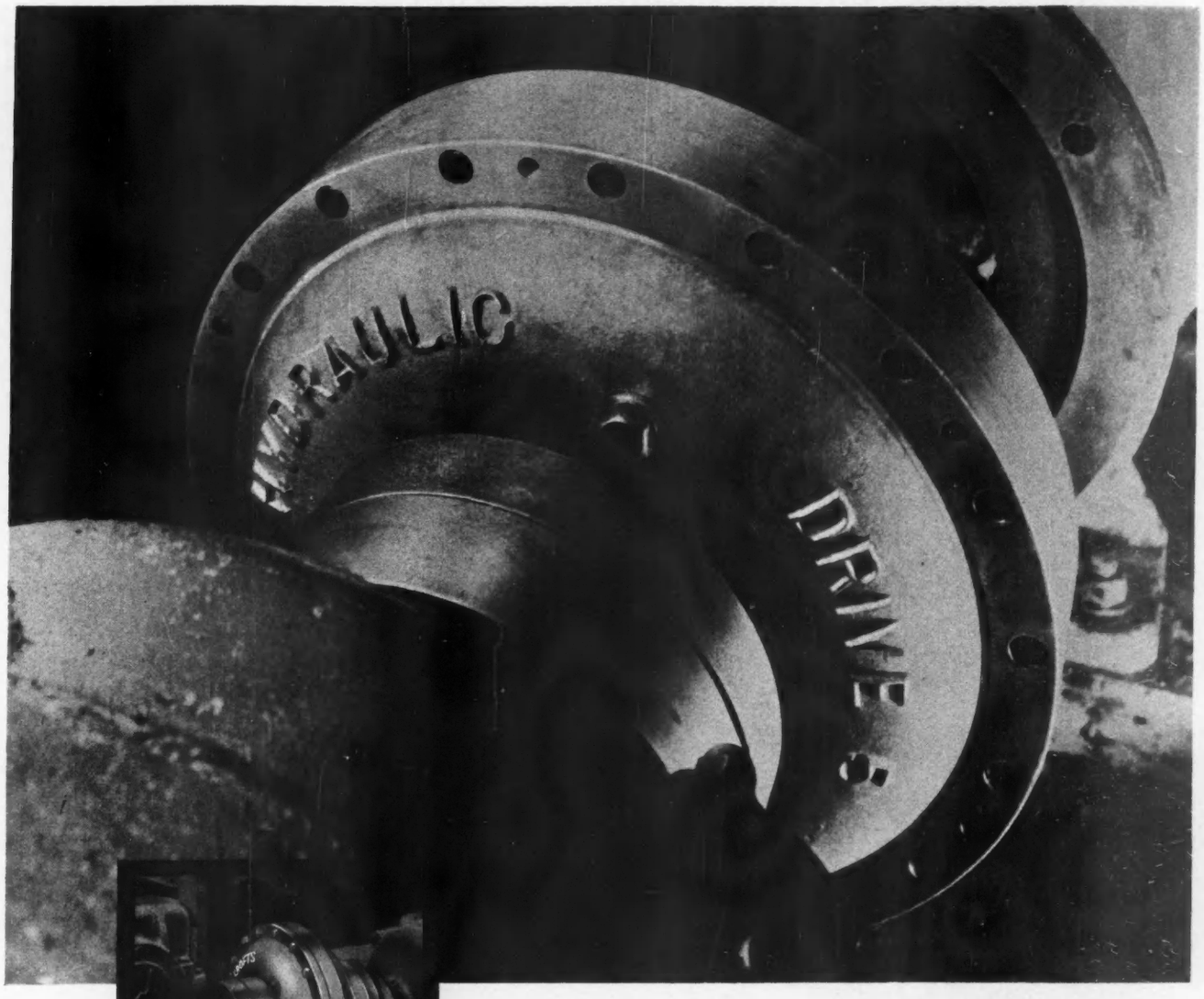

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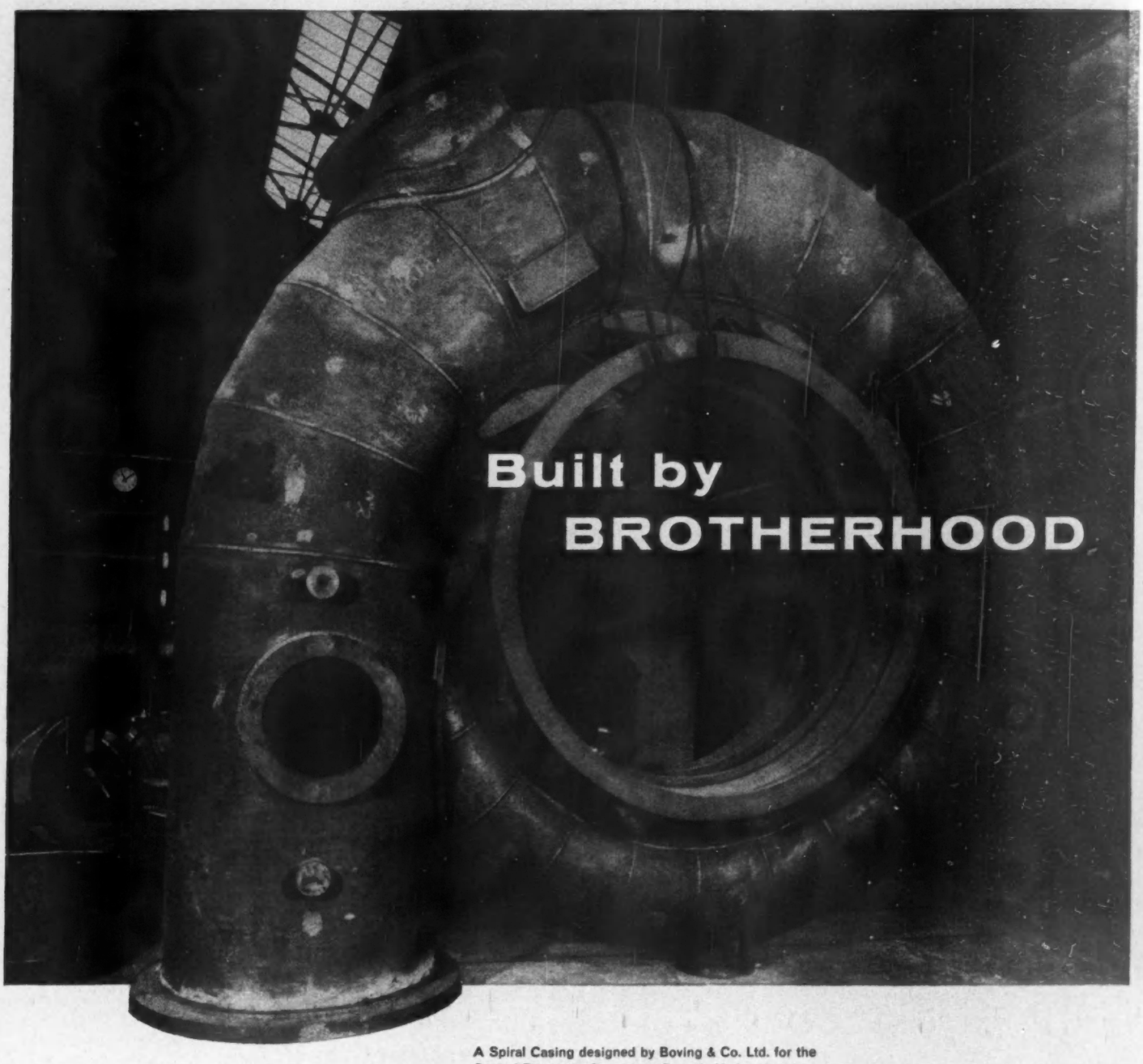

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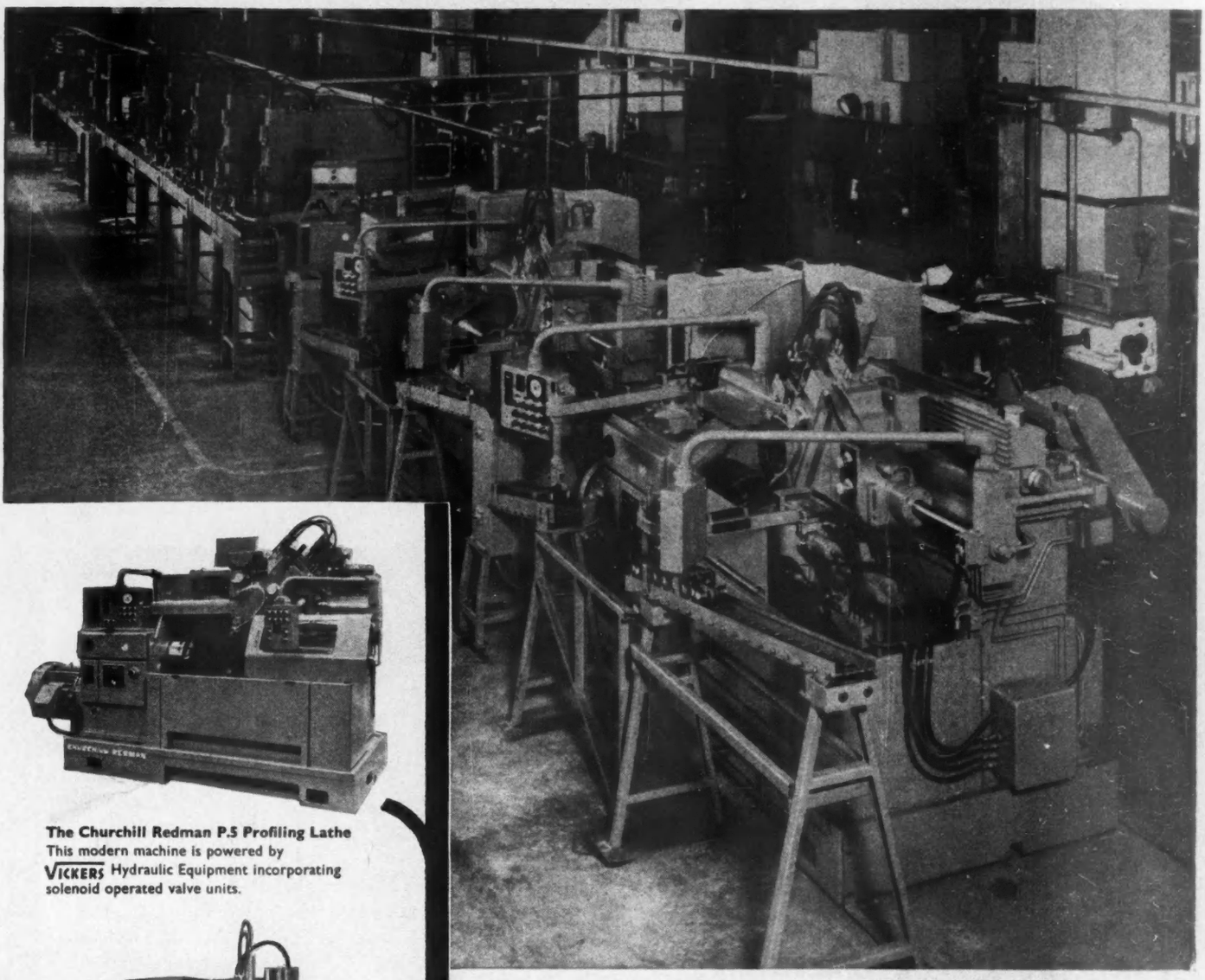
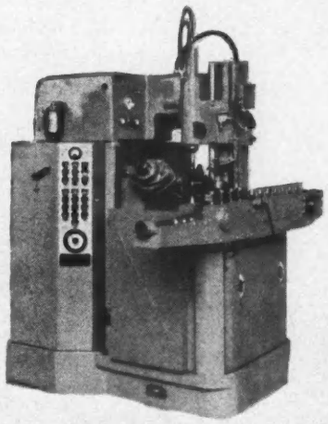


A "Link-Line" of two Churchill Redman P.5 Profiling Lathes followed by five Churchill S815 Mark IV Rigidhobbers.
Photograph by courtesy of Charles Churchill & Co. Ltd.

The Churchill Redman P.5 Profiling Lathe
This modern machine is powered by VICKERS Hydraulic Equipment incorporating solenoid operated valve units.



The Churchill S815 Rigidhobber
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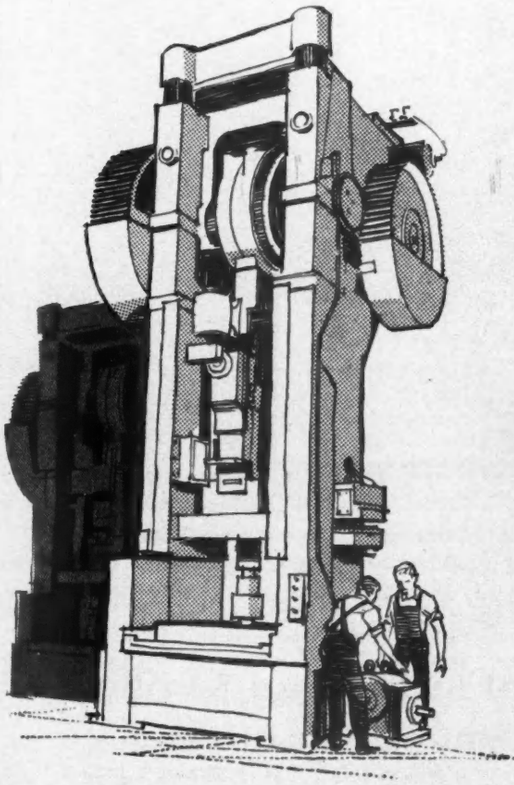

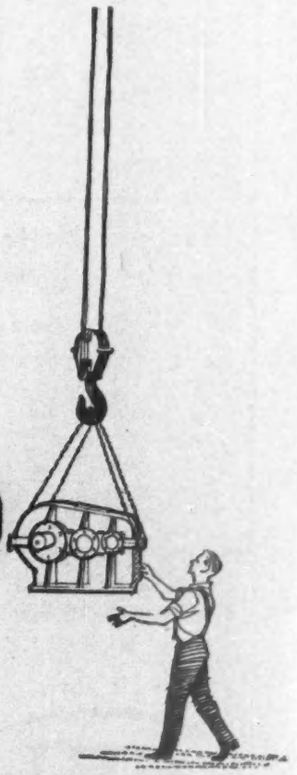

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*55	720	50	1475
70	720	50	730
*75	970	65	1475
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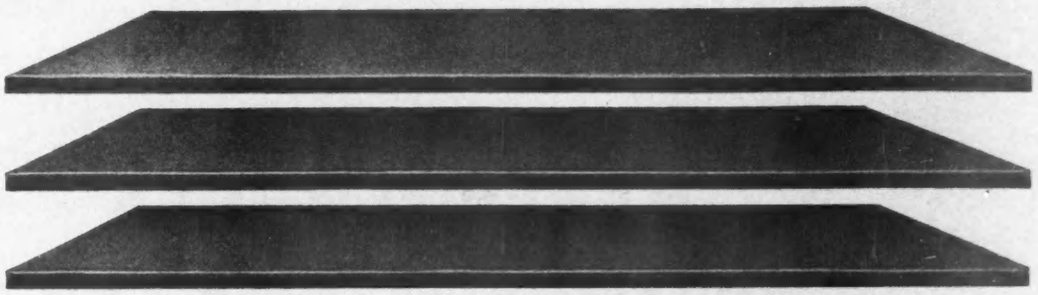

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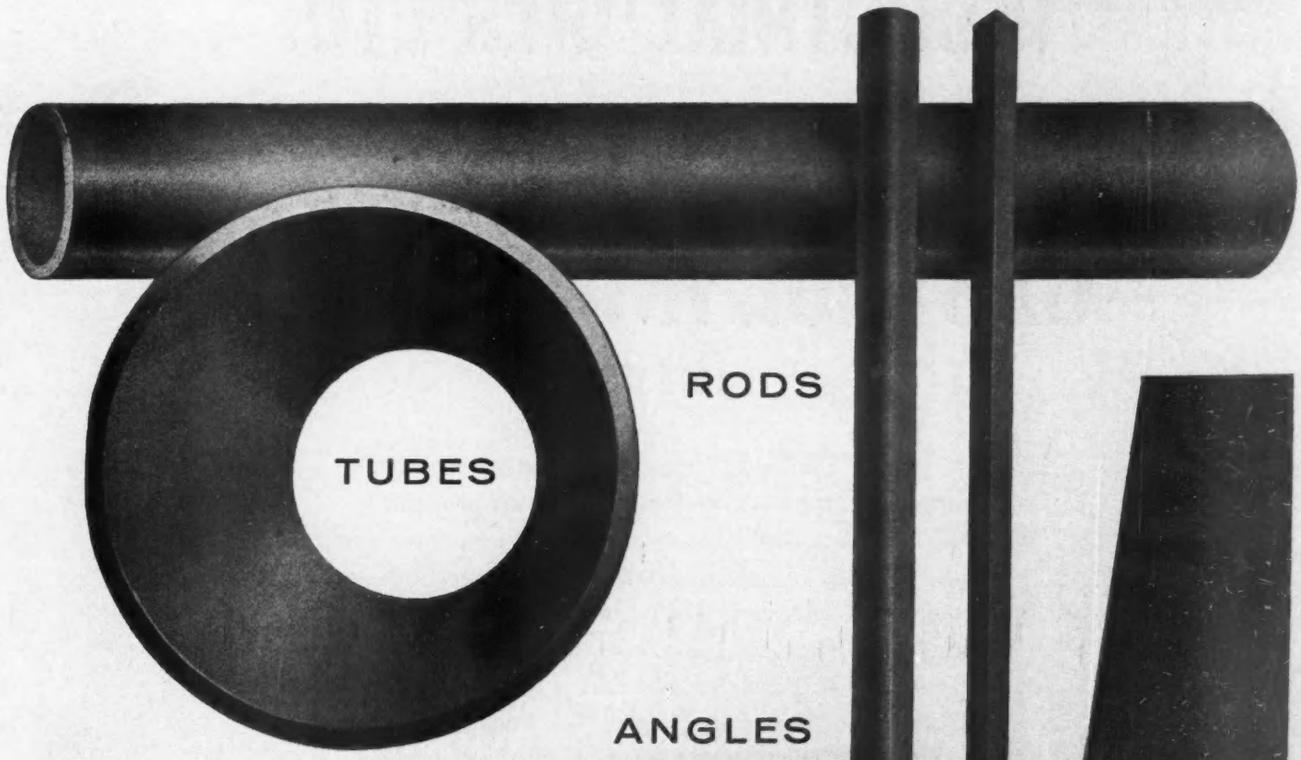
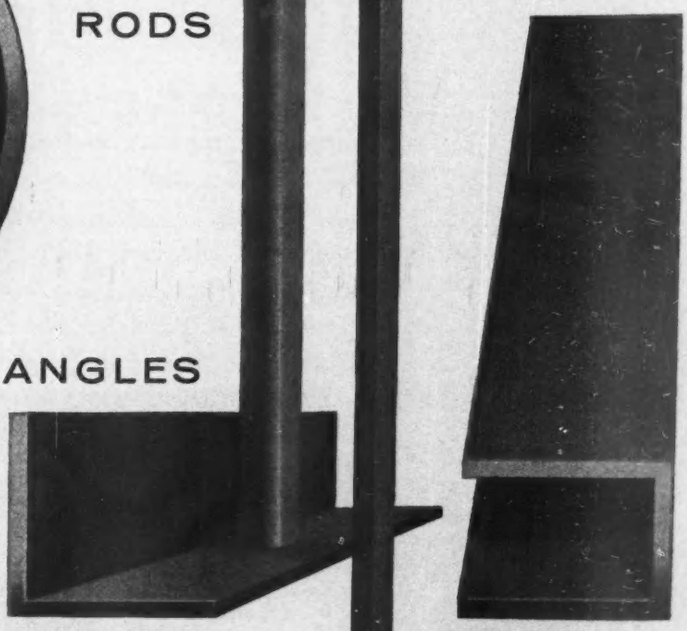


RODS

TUBES

ANGLES



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On the 2nd January 1961 we will, subject to the approval of the Board of Trade, change our name from Wakefield-Dick Industrial Oils Limited to Castrol Industrial Limited. Many customers have always called us the "Castrol Firm", yet some of our older friends will wish to know the reason for the change. Since the war, our world business has multiplied, and with the post-war generation it is the name Castrol which has the greater significance. Therefore, to simplify the identification of our group, we have decided that our Industrial Company will go forward under the Castrol name.

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ENGINEERING Impact

of the Cost Engineer and Constructive Management

FORMATION of an Association of Cost Engineers in Britain may lead to far more than organisation of another engineering specialism into its own body.

A growing readiness to acknowledge the importance of engineers taking board room responsibilities is widely discernable. The rise of accountants from the counting house side of business to the top commands has been a feature of industry and commerce during decades when a great deal of activity has gone into the setting up of great industrial empires and also into the maintenance of a closely woven web of trading agreements.

The harsh facts of our overseas trading position, and the impact of legislation against restrictive practices at home, must tend to bring out the importance of again heading industry with men whose abilities are constructive; men capable of putting in the hand of the world tools for work, as well as toys for leisure, that are in advance of what others have so far done and at times even ahead of what people have yet come to demand.

Fresh Resources

There is a very real sense in which an accountant manipulates but never creates. The engineer not only creates but "can do for £100 what any fool can do for £500." This is something more than saving, in that, assuming the other £400 would have been spent, resources are freed to do another job sooner.

Since money and the conditions of trade are inseperable from running a solvent enterprise, the engineer who is something more than aware of this side of life has an important contribution to make. This is where the cost engineers come in. More able than most to talk to the creative engineer, and able also to put the technical side to the accountant and the salesman, there is hope that the men in this field may lead a real break through to the reappearance of the engineer in the leading ranks of industry.

It is significant that the early days of the Association of Cost Engineers in Britain see the swiftest development in the chemicals industry and in the process industries.

Engineering Experience and Industrial Leadership

Six years ago in many companies in the United Kingdom's engineering industries the voice of a technically qualified man was never heard: thus Mr. Bosworth Monck, a director of Spicers, quoting a British Association paper "The Eclipse of the Engineer in Management" (ENGNG., 10 Sept. '54, p. 329. Vol. 178) at the recent conference of the British Institute of Management on the importance of engineering services to modern management. Mr. Monck fears the position is much the same today. May there not be a parallel between this position and the decline in the United Kingdom's share of the world's export trade from 20·3 per cent in 1954 to 17·3 per cent in 1959? Few enough are the examples in transport, food, textiles, distribution—even the growing plastics industry—where engineers are found in the boardroom.

The application of money to the best advantage means translating it into ironmongery, in Bosworth Monck's phrase, with which to make something, move it and put it to use. All of which is no more than a roundabout expression for engineering.

Intolerance is often found among engineers, arrogance among accountants, but fortunately both qualities can be disposed of in the right atmosphere. Dangerous mistakes are often made by the amateurs, simply because they suppose a knowledge of figures and finance justifies a high position, whereas technical knowledge has no such halo.

Getting right to the heart of this problem, Bosworth Monck asserts that the right engineer and the right accountant can together make for a sound engineering policy. But even an engineer of modest ability, being a natural creator, is better on his own than when hamstrung by the wrong kind of accountant.

But technical qualification is not enough. The engineer must be articulate, and articulate n terms which the amateur can understand. While the accountant specialises in hindsight, the engineer must specialise in foresight. He must draw on past experience to forecast what can be made to happen in the future.

It is the ability to do so which distinguishes the engineer from the engineer-manager, and it demands an understanding of disciplines other than his own.

On the simplest consideration of the figures it is possible only to disagree with Bosworth Monck when he says he believes that this country is not short of technical men.

But he explains that he thinks the country is only short of technically qualified men able and eager to take on this kind of responsibility. Still they do exist, and it is for the more enterprising managements to seek them out and make use of them.

One certain effect of putting more engineers into the boardrooms of manufacturing industry would be another look at the important question of depreciation allowances. Bosworth Monck's contribution to this is the germinal suggestion that perhaps for a period of three to five years the depreciation entitlement should only be paid to companies which could show that they had spent at least equal amounts on new equipment, either for expansion or in replacement.

of Freedom for the Institutions

After a four-year legal fight, the Institution of Mechanical Engineers has lost its case. It cannot claim exemption from rating under the terms of the Scientific Societies Act, 1843, as its appeal was dismissed last week by the House of Lords.

It is impossible to foretell the consequences of this decision but they may well be far-reaching. There is, of course, the immediate and inevitable result that the Institution will have to pay substantial arrears of rates, and the members' subscriptions may have to be increased. There is also the likelihood that other engineering institutions will accept the "test case" of the Mechanicals as applicable also to themselves.

But the point of greatest importance for the future is that the Council of the I.Mech.E.—and no doubt those of the I.C.E., I.E.E., and I.Chem.E.—can feel free to interpret their charter in much wider terms than they have done in recent years.

Art and Practice

They are now at liberty to give some attention, if they wish, to the "material interests of members." They have no need to adhere to the idea that the Institution was instituted exclusively for purposes of science (Lord Radcliffe said that it would probably be a less effective body if it had). Viscount Simonds said that "so far as 'mechanical engineering' connoted scientific work, it must involve art and practice also."

Will the Institution now take on some of the responsibilities and activities which it has been leaving to the Engineers' Guild? The answer to that question—which rests largely with Council members, present and future—could have considerable repercussions on the profession and the engineering industries.

and O Sole Mio and a Shortage of Bricks

The connection between Italian opera and the cronic British brick shortage is direct and painful.

Along with other industries in the United Kingdom, the brickmakers need more labour than they can currently recruit if they are to expand production to meet the heavy demand from house and office construction.

One and a half million bricks a week are lost at one company alone, the Marston Valley Brick Works, outside Bedford, because there are not the men the firm needs. The company would like to employ another 200 immigrant Italian workers. The Transport and General Workers Union and the Ministry of Labour have both given their blessing to the arrival of the Italians. But the town of Bedford already has an Italian population of one in fifteen of its people. And the Borough Council is opposed to having any more living in the town.

The Mayor of Bedford has stressed that the objection is to foreigners as such, and not to Italians. Of Bedford's 60,000 people, some 10,000 are from overseas, 40 per cent of them from Italy. One of the things that evidently upsets the natives of Bedford is the way in which an Italian brickyard worker may sing his way along the street on the way to work at 6.30 a.m. The Mayor has emphasised the local point of view with the retort that the people who are concerned about the national shortage of bricks do not have to live alongside a noisy and voluble Italian populace.

It is more than unfortunate that expansion of the local industry should be held back because the local people, after long exposure to the Bedfordshire climate and all the other influences that go to make the Englishman later and quieter on his way to work, cannot stand the fact that the necessary foreign labour transfusions that our industry, or certain parts of it, must have for growth, mean some change will take place in the areas where the newcomers settle.

Western Germany has taken in Spanish and Italian workers by the hundred thousand as the "economic miracle" has absorbed the available German labour force.

Do the West Germans complain about Romantic voices uplifted in Mozart arias under their dawn windows? Or do they respond with the more heroic strains of Tannhauser and Siegfried?

If there is to be a miracle of increased production in Britain, which certainly we need, then perhaps the people of Bedford, and elsewhere, will have to learn that putting personal ease before industrial activity is a sure step down a disastrous path.

The Circulation of "Engineering"

Mr. John A. Dixon, chairman of Engineering Limited, and publisher of ENGINEERING, *is happy to announce that he has applied on behalf of the journal for membership of the Audit Bureau of Circulations. This is a move of great significance for advertisers, and ultimately for readers, because it is the best possible indication of the present circulation of* ENGINEERING *and of its future prospects.*

The enormous growth of specialised trade and technical journals in recent years has now reached the point where there is a greater need than ever for a journal such as ENGINEERING *which reaches into all industries where engineers and engineering contribute to progress.* ENGINEERING *was founded nearly a hundred years ago, when there were very few other journals competing for readers. Now, in the 1960's, it is attracting new readers every week because it keeps abreast of the latest developments and because it enables the reader to apply the best ideas to his own problems.*

Joining the Audit Bureau of Circulations will mean that early next year an ABC certificate will be issued showing the independently audited circulation of ENGINEERING. *The certificate will show the figures for the year 1960, and certificates issued subsequently will keep advertisers informed of the up-to-date position.*

There is no compulsion about joining ABC. It is a wholly voluntary move. It shows that ENGINEERING *enjoys a wide circulation. And it is a move that is being welcomed by advertisers and their agents.*

Taking Steps Towards Avoiding Corrosion

Be realistic about corrosion. It can be prevented or you can pay for the damage. With the same money involved it is more sensible to live with something protected than with something deteriorating.

SIR ALEXANDER FLECK: "I find that it is a very pronounced fashion that people who are interested in corrosion open their remarks with a reference to the Delhi Column—the column now standing more than 20 ft high in Delhi composed of 99·7 per cent or thereby of iron which has stood since A.D. 300. I am very glad to conform to fashion . . . We have, however, a very interesting example of corrosion resistance of ancient iron nearer home." At a site called Inchtuthil, 12 miles north of Perth, 12 tons of nails were buried in a large pit when the fortress was evacuated about A.D. 90. They comprise nails of every size from 2 to 16 in in length and the bulk of them are in remarkably good preservation.

"We must not, however, linger in the past . . . *The exhibition is open.*" The fourth Corrosion and Metal Finishing Exhibition was organised by *Corrosion Technology*. Here are the highlights and a few inside comments gleaned from a stroll round the stands. The following products deserve careful thought, and literature can be obtained for most of them by writing to the firms.

Products and Firms Mentioned in this Review of the Corrosion Exhibition

Corrosion Resistant Structures	
Tanks in pvc and reinforced plastic	Tough Plastics, Addlestone, Surrey
	ICI, IC House, Millbank, London, SW1
	AC Plastic Industries, 1-3 Long Street, London, E2
Welding polycarbonate	Plastic Filters, Horsham, Sussex.
Industrial cladding	Dorman Long & Company, 52 Grosvenor Gardens, London, SW1
Corrosion Resistant Pipes	Chemidus Plastics, Progress Way, Croydon, Surrey
High pressure epoxy pipe	Bristol Aeroplane Plastics, Filton House, Bristol
Surface Preparation and Primers	
Silica-free grit	Appleby Abrasives, Brigg Road, Scunthorpe, Lincolnshire
Primers for rust control	Hunter and Company (Holdings), 27 Albemarle Street, London, W1
	BB Chemical Company, Ulverscroft Road, Leicester
	A. Sanderson and Company, Kingston Paint Works, Hull
	Croda, Cowick Hall, Snaith, Yorkshire
Metallic Coatings	
Chromising	Metallic Surfaces Research Laboratories, Uxbridge, Middlesex
	Zinc Alloy Rust-Proofing Company, Shakespeare Street, Wolverhampton
Metallising	Metallisation, Dudley, Worcestershire
Tin-nickel plating	Tin Research Institute, Perivale, Greenford, Middlesex
Rubber Coatings	Protective Rubber Coatings (Bristol), Payne's Shipyard, Bristol
Coating service	Coating Contractors, Buckingham
	E. and F. Richardson, Buckingham
Plastic/rubber linings	Dunlop Rubber Company, Cambridge Street, Manchester 1
Plastic Coatings	
Penton	Hercules Powder Company, 1 Great Cumberland Place, London, W1
	Plastic Coatings, By-Pass, Guildford, Surrey
Sprayable pvc	Plasinter Company, Holyhead Road, Wednesbury, Staffordshire
High build epoxy	CIBA (ARL), Duxford, Cambridge
Phenolics and modifications	James Lithgow (UK), Buckley, Flintshire
Anti-stick silicone formulations	Wolseley Holdings, Caton Road, Lancaster
Other Protectives	
Strippable coatings	Croda, Cowick Hall, Snaith, Yorkshire
High build bitumen	Griffiths Bros. and Company London, Wednesfield, Wolverhampton
Zinc silicate	MacCleaster Chemical Company, 8 Great Tower Street, London, EC3
Sprayable foam	Aerograph-DeVilbiss, 47 Holborn Viaduct, London, EC1

Corrosion Resistant Structures

Tanks in Pvc and Reinforced Plastic.—Tough Plastics are getting the best of two worlds by working with both reinforced plastics and pvc. For large tanks and pipes with diameters running into feet, they often recommend their composite material called Tufplas. They weld up a structure of rigid pvc which has good chemical resistance, and they spray on an adhesive system and reinforced polyester. The company are known for talking a lot of good sense when it comes to choosing a plastic for such applications, and they seem to have made such fabrications a paying proposition, which does not apply to the whole of the industry. ICI supply them with Darvic pvc sheet.

AC Plastic Industries also say they can now positively bond polyester resin to rigid pvc which "offers new fields in the construction of chemical plant, due to temperature resistance of over 65° C, greater impact strength and rigidity." It would not be wise counsel, however, to recommend use of such composites over 65° C because pvc rapidly softens above this temperature. In this material they offer a range of fans. They can also offer polypropylene pipe up to 3 in bore, which might be worth trying out even though it is more expensive than high density polyethylene pipe.

Welding Polycarbonate.—Plastic Filters have experience in welding polycarbonate sheet which has a useful temperature limit of 130° C. This plastic is seldom seen in the UK, being made in Germany and America. It is vaguely similar to acetal plastics such as are made by Du Pont under the name Delrin.

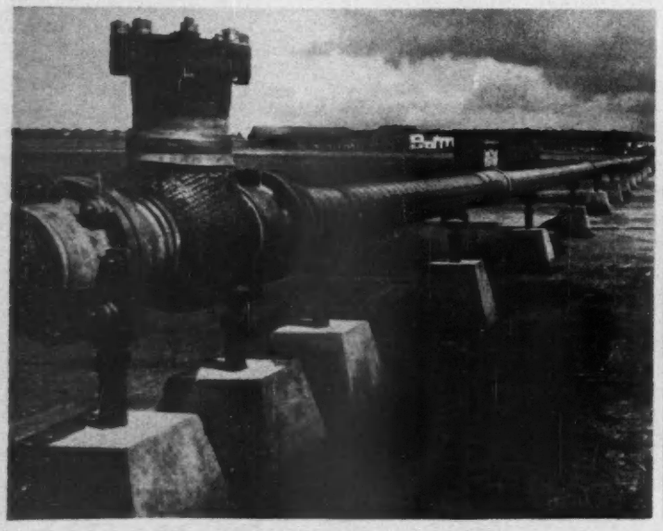
Industrial Cladding.—Dorman Long have recently introduced a new sheet steel coated with pvc for industrial cladding. This coating was devised by G. A. Willis; apparently it is applied as a plastisol rather than as a pvc laminate. It is thus similar to the product made by Coated Strip, though much wider, and the pvc formulation is probably more heavily pigmented for outdoor weatherability. The sheets have withstood accelerated laboratory weathering tests for 10,000 hours—estimated to be equal to 25 to 30 years of normal use; but accelerated tests don't always tell the whole truth.

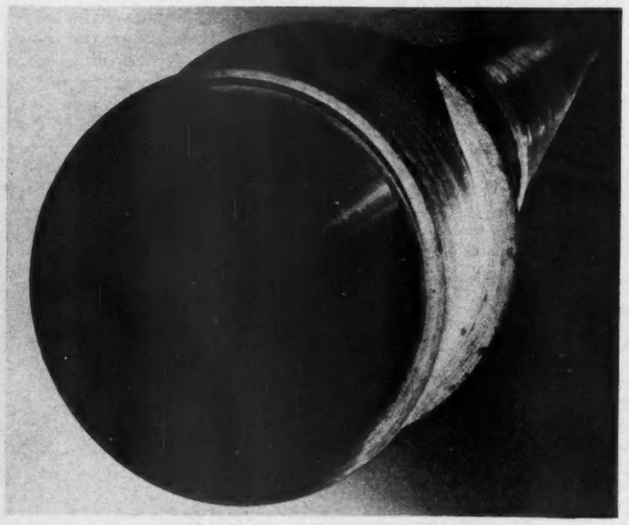
Corrosion Resistant Pipes

Chemidus Plastics is one of the firms who now sell the medium-impact high-strength pvc piping from resins supplied by British Geon. This has mechanical strength around the 7,000 lb per sq. in mark and is said to have good long term properties.

High Pressure Epoxy Pipe.—Bristol Aeroplane Plastics are now getting serious about their Epoch piping which is made on highly automated plant from continuous glass roving and epoxy resin. It is intended for high pressure lines (up to 600 lb per sq. in working pressures) and they have developed junctions and joints to the American Petroleum Institute's specifications for high pressure piping. It is not easy, however, to insert take-off lines, except small diameter ones, other than at the design stage; but there are techniques for mending damage and for obtaining high strength bonded joints to steel. There is a definite fire risk in environments above

High pressure Epoch pipe is in glass reinforced epoxy. Note the smooth bore.





about 500° C and the company will probably develop winding asbestos or aluminium foil into the top surfaces to overcome this.

This is an outstanding product which costs roughly four times that of mild steel pipe and half that of stainless steel pipe, but it appears that more service trials will be required before it will be widely accepted. The plant at Bristol can make up to about 100 miles per year in total which is something of a limitation if the company are to tap the material's largest outlet —for pressure pipelines in the petroleum industry.

Bristol hope to sell the material abroad. Encouraging trials have been held by Bowaters, who were having great difficulty with stainless steel, and by the Admiralty, who have found little erosion after passing unfiltered salt water through the tube at 30 ft per sec (far above the accepted maximum of 10 ft per sec) for 1,600 hours. Variation in properties of sample tubes is within 7 per cent—a very good figure for any reinforced plastic product.

Surface Preparation and Primers

Silica-Free Grit.—Appleby Abrasives, who are closely associated with the United Steel Companies, have developed and brought on to the market a very efficient low priced expendable grit blasting abrasive under the trade name Silikasafe. It contains no free silica.

Primers for Rust Control.—Hunter and Company make a primer for steel which is already rusty. It doesn't remove the rust, but inhibits further action by having high alkalinity. Remember adding alkali to boiler water for this purpose? Hunterseal as it is called, is especially useful in the shipbuilding industries.

Metal parts protected with Bostik Endurion may be expected to remain serviceable 16 times as long as parts treated with phosphate, and four times as long as parts treated with phosphate and oil. The smooth, flexible surface facilitates cold working processes such as drawing, stamping and forming.

The combined primer and rust remover made by A. Sanderson and Company is worth trying. It is called Kingston Kurust. It combines an iron phosphate rust remover and inhibiting chemical, a resin which binds all the products of reaction together when the phosphate has done its stuff, and some lead thrown in for good measure. It's not black, but comes in colours.

Metacon, made by Croda, will derust metal surfaces even though they are covered with grease or oil.

Metallic Coatings

Chromising.—Metallic Surfaces Research Laboratories have developed a new method of getting chromium into the surface of steel, and the process is offered to the trade through Zinc Alloy Rust-Proofing Company. It is called Arkrom, and it is not yet obvious how it differs from the various chromising processes already in existence so far as the end product is concerned.

Metallising.—There is still plenty of business in spraying aluminium and zinc as Metallisation will vouch. They operate both rod and powder spraying equipment but always prefer the rod method. Air pressures with this method have to be higher, and they think this is advantageous in getting a higher density coating with good adhesion.

Tin-Nickel Plating.—The Tin Research Institute are happy about progress of their tin-nickel plate. This is one coating produced from one chemical bath. Many electroplaters in the United Kingdom, they say, are now equipped and are regularly applying the electroplate for scientific instruments, watches, drawing instruments, cooking utensils, and for dies and moulds used in industry.

Rubber Coatings

Protective Rubber Coatings (Bristol) have developed a range of liquid-applied self-curing synthetic rubbers under the name Limpetite. These can be applied *in situ* or at their works. The company have coated many cast iron waterboxes for a nuclear generating station.

Coating Service.—Coating Contractors are progressing well since their formation over a year ago. They were created from the field application team of E. and F. Richardson, who make high-build coatings. They have cut out most trade application of their materials and thus obviate mistakes which can occur when this work is done by people who haven't had too much experience in handling the coatings. Their coatings are mainly elastomerics based on neoprene, Hypalon and Viton, but there's also an epoxy-tar coating and one based on polyurethane.

Plastic/Rubber Linings.—Dunlop have developed an anti-corrosion lining which is made up of two layers bonded together—rubber on polyethylene or polypropylene. The rubber is cured *in situ* with the plastic up against chemical attack. This seems a good way to bond these plastic liners to metals, for they expand up to 12 times as fast as steel when heated up. Success all depends on how strong the linking is. Dunlop describe this as " extremely strong."

Plastic Coatings

Penton Useful up to 130° C.—Hercules Powder Company is devoting much of its energies to promoting the use of Penton. This is a chlorinated polyether. In appearance and feel it resembles nylon and has been made in solid form by Polypenco. It is very expensive and it is not yet obvious where a large market will be developed for the material. The makers would like to see it used for surface coatings where, by application with the fluidised bed technique and sintering at 300° C, it can be made with negligible porosity. The high temperature limit of 130° C is attractive. Plastic Coatings have coated valves in the material and think it will compete with ptfce which is proving difficult to apply in practice. But it's very expensive compared with pvc coatings.

Sprayable Pvc.—Despite the wide range of coatings which *can* be applied to metals, such as nylon, polyethylene, CAB (cellulose acetate butyrate), ptfe, ptfce, cpe and epoxide, the one which attracts most business is pvc. Plasinter Company will apply all those mentioned above. But they draw attention to pvc spraying finishes which provide a tough decorative coating of high abrasion, electrical and corrosion resistance. This is like a conventional paint for *in situ* application rather than those used in the plastisol dipping technique and fluidised bed method which mean sending the work away to be coated.

High-Build Epoxy.—CIBA make solvent-free resin systems enabling epoxy coatings up to 0·020 in to be applied in one operation. This type of coating is used extensively for protecting and strengthening the lagging of pipes in chemical plants, but is expensive.

Phenolics and Modifications.—James Lithgow (UK) make a range of sprayed, trowelled and laminated plastic coatings. The name to remember is Calvinac. Their phenol formaldehyde coatings are exceptionally tough as are their phenol-epoxy coatings. What is more, it has been shown that they work in such articles as centrifugal pumps and chemical tanks with good results. It is said that most of their phenol-based coatings can only be applied in a few mils at a time and become expensive (compared with rubber and plastic coatings) when built up thick. Corrosion resistance of their vitreous enamel for steel is better than average.

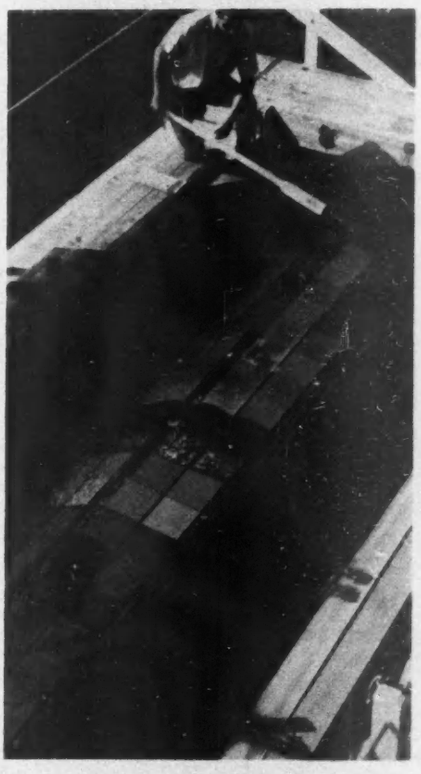
Anti-Stick Silicone Formulations.—Wolseley Holdings seem to be having success with their coating formulations. They are mainly thermosetting and include both phenolics and silicones. The company have done a lot of work in developing coatings which resist build up of slurries and powders—in other words, with anti-stick properties. The name to look for is Lanshield Sakaphen.

Other Protectives

Strippable Coatings.—Croda have developed a cold-applied strippable coating which they call Promex. Coatings with this material are only a few mils thick compared with 60 mils which can easily be obtained with their hot dip coatings. They recommend the cold one where hot dipping is out of the question.

High-Build Bitumen.—Griffiths Bros. and Company have put a grin on the black face of bitumen coatings. Their Melanoid coating is thixotropic, which means that film thicknesses running into tens of mils can be put on in one coat. The material is also said to have better water resistance for any given film thickness than conventional black bitumens.

Zinc Silicate for 600° C.—MacCleaster Chemical Company seem to have developed an interesting material which is based on zinc silicate. It will withstand 600° C and is called Dox-Anode. This coating is being used as a tank surface coating for oil-carrying tankers and, in Germany, vessels carrying styrene monomer are being treated with it. Apparently it is equally effective whether air-dried or stoved.



One of the turtle plate-carrying rafts at International Paints' marine biological research station at Newton Ferrers, Devon. The raft has been turned for assessment of the performace of anti-fouling compositions in preventing marine growths.

E. Wood also make a coating of this nature called Met-L-Plate Z which has been applied to to the insides of pipes.

Sprayable Foam.—Aerograph-DeVilbiss have made equipment for spraying rigid polyurethane foams blown with Freon, a hydrocarbon gas with half the thermal conductivity of air. Foams initially have conductivities around 0·14 Btu per hr-sq. ft-°F per in. Two components of plastic are heated and mixed before entering the spray gun. Here they meet liquid Freon and mix with it. About five minutes after hitting the surface the Freon is fully evaporated and the foam has risen anything up to about 20 times its original thickness. The insulation material can be sprayed up or down-hand, seems to have good adhesion, and does not fall to bits easily. But the equipment is cumbersome and is not yet available in quantity.

Plain Words

By Capricorn

THE power to see ourselves as others see us is no more easily acquired by a firm than by an individual. The face of a firm may be more sharply defined to the newest recruit than it is to the chairman.

A recent Management Selection advertisement revealed a new approach to this problem. It gave the organisation tree—the top branches of the tree—of "an international company with turnover of $800,000,000 in the telecommunications and electronics field." In spite of the company remaining anonymous, the overall effect of the advertisement was powerful. The top job shown on the tree was the general manager, European area (20 companies), and under him were the director of telecommunications marketing, the director of component marketing, and the comptroller. These topmost jobs were already filled, but by showing them on the tree it was clear to the reader how the four vacant jobs fitted into the organisation. The four jobs themselves—for managers of marketing or product cost control—were then defined in some detail. Duties and requirements were specified.

I saw an entirely different kind of "company projection" last week. Imperial Chemical Industries Limited have completed a film which leans over backwards to avoid giving any suggestion that it is intended to boost the company. It is called "New Minds for a New World," and it deals with some aspects of science in the universities, the teaching profession and industry. An entertaining, discussion-provoking film, it includes one or two quite brutal comments on I.C.I.

Such activities by large industrial companies are appropriate to our times and conditions, but how easy it is to go wrong in these matters is shown by the recent case of the commanding officer of a Royal Engineer depot who introduced some novel methods of stimulating recruitment. He offered incentives to the men of his depot who could get their friends to join up: £2 and one week's leave per recruit recruited, 10*s* for testifying in a local newspaper to the advantages of Army life, and promotion to lance-corporal for bringing in recruits.

I thought this showed great enterprise on the part of the commanding officer. It was a little crude, perhaps, but it could have been refined to make it into a cultured, 20th century version of the press gang. The scheme raised comments of the "we are not amused" kind and a question in Parliament finally did it to death.

It is difficult to say in this case whose face has suffered most by the experiment, the depot's or the C.O's, but among the local people it must certainly have had an image-forming effect. Maybe some recruits will now come in as a result of the publicity. Will the C.O. then get promotion? Only if some way can be found to save the face of the critics.

Letters to the Editor

Keeping Oneself Informed

SIR, We have read with interest the article by C. W. Hanson on "Deciding What to Read to Keep Informed" (ENGNG., 16 Sept. '60, p. 378).

The Engineering Index is a non-profit corporation devoted to a world-wide annotation of engineering literature. Its bound volume is issued annually and may be found in the public libraries of most of the more prominent industrial manufacturing cities of England.

The service of the Engineering Index is two-fold: providing a bound volume of over 1,600 pages, issued annually in June, and a library card service, issued weekly, on each of 249 divisions of engineering. The card service enables a subscriber to obtain information on his "field of interest" subjects. It gives him information on articles printed in over 1,700 technical periodicals published in 44 countries around the world.

The bound volume contains an index of authors covering more than 100 pages, and an index of the 1,700 or so periodicals reviewed. The literature is received by the Engineering Societies Library of New York and the literature reviewed by the Engineering Index is kept on file there. The library has a service for providing microfilms or photo-copies of any complete article and also for making translations from, or into, any language.

The many readers of ENGINEERING should be interested in this angle of "What to Read to Keep Informed."

Very sincerely yours,
ERNEST HARTFORD,
Director of Promotion.

Engineering Index Incorporated,
New York 18, USA.
16 November, 1960.

Traffic Problem Solved?

SIR, Capricorn warns us of "the communication mess in which we are landing ourselves" (Plain Words, ENGNG., 4 Nov. '60, p. 600). Are we right in restricting the discussion to road versus rail? Are there not other methods of land transport of which we should not lose sight?

Too often we assume that our wheels will for ever keep turning on stationary roads, omitting the possibility of the roads/or rails themselves running too. At the 1900 Paris World Fair there was exhibited a *tapis roulant*, or travelling platform, which may be considered a forerunner of our trav-o-lator (see ENGNG., vol. 69, 1900, pp. 705 and 807). But the idea was not new even then.

Already, in 1897, the German poet Kurd Lasswitz, Professor of Mathematics at Gotha in Thuringia, described in one of his science fiction novels how the Martians had tackled their traffic problems, and I give below quotations from a translation of the relevant paragraphs:

"On Mars, two different systems served the fast traffic over long distances: they were the slide roads and the wheel roads. Radiation from the sun proper supplied the power. On the slide roads there was a thin film of lubricant between the rails and the load which was supported by slides incorporating ball bearings.

"One used the wheel roads only for long-distance travel needing minimum delays. The common conveyance was the wheel slide, a light car seating only two people, and driven by a small motor underneath the seat. The car rested partly on slides, and partly on wheels. In addition, there were the step roads with their closely knitted network covering all residential areas, with a regular spacing about six miles apart. These step roads were the ideal roads putting into reality that dream phantasy of fairy tale writers that the roads themselves moved instead of the travellers.

"The roadway proper measured about a hundred feet in width, with the same width required for the feeder roads running in parallel to the main road on either side. Feeder roads consisted of twenty strips each about five feet wide, and all mounted closely together. The outermost feeder lane moved at a speed of 6·7 miles per hour while the speed rose by ten feet per second for each adjacent lane inwards, so that the centre lane, serving as the main road, travelled at a velocity of 135 miles per hour. Every point on this centre lane thus covered a hundred and thirty five miles per hour. The lanes constituted conveyor belts and were driven by rollers. One could travel on the step road on foot as well as by one's own wheel slide, and mount the road or alight from it anywhere.

"People got easily on the first lane, and, with equal ease, on every subsequent lane moving at the same rate in relation to the previous one. Proceeding obliquely, one thus attained the main road, and its speed, either on foot or by car. Walking or riding, one followed the main road, and alighted from it at will in the same manner on the opposite side. Mounting it on the left-hand side one left the step road on the right. Light bridges were provided every hundred and ten yards for crossing."

Yours faithfully,
A. LASSALLY.

Richmond, Surrey.
24 November, 1960.

Events in Advance

Communications Satellites

A ONE-DAY symposium on the uses of communications satellites has been organised by the British Interplanetary Society and is due to be held at the offices of the Federation of British Industries, 21 Tothill Street, London, SW1, on 12 May, 1961.

As at present arranged, at least six papers will be presented. They will include "Communications Satellite System Suitable for Commonwealth Telecommunications," by Dr. W. F. Hilton; "The Synchronous Communication Satellite," by R. P. Haviland; "Low-Cost Communications Satellites," by A. M. Peduzzi; and "The Engineering and Economics of Satellite Communication," by G. K. C. Pardoe.

Communications relating to the symposium should be addressed to the secretary, British Interplanetary Society, 12 Bessborough Gardens, London, SW1. Telephone: TATe Gallery 9371.

User Experience of Industrial Vacuum Plant

FOLLOWING upon a recommendation by the Joint British Committee for Vacuum Science and Technology, the Council of the Institution of Mechanical Engineers are organising a symposium of papers to discuss user experience of large-scale industrial vacuum plant. The meeting will be held at the Institution on 1 and 2 March, 1961, and the arrangements are being undertaken by a committee consisting of representatives drawn from the constituent bodies of the Joint British Committee.

The main objective of the symposium is to bring together designers and users of vacuum plant in order to discuss their particular problems and techniques. It is felt that both designers and manufacturers will benefit from a study of users' experience with this type of plant and that, conversely, users will welcome the opportunity to put their experiences on record.

Proceedings will open with a short session on the afternoon of 1 March, at which a general review paper will be presented, followed by papers on vacuum processing and the treatment of metals. On 2 March, there will be both morning and afternoon sessions. At the former, further papers on metallurgical subjects will be considered, together with a contribution on steam ejection vacuum plant and a paper on capacitor

drying. At the afternoon session, a group of papers covering the medical and food-processing aspects of the subject will be presented.

Registration of those desiring to attend will be required, applications in respect of which should be addressed to the secretary, the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. Telephone: WHItehall 7476.

New Approaches to Heating and Ventilating

DURING recent years, many new developments have taken place in the realms of heating and air conditioning, both in this country and overseas.

Much interest will centre, therefore, upon the forthcoming Heating, Ventilating and Air Conditioning Exhibition, and that event will provide British manufacturers in this field with an almost unrivalled shop window for demonstrating to all concerned the strides that have been made. The exhibition, known generally by its short title HEVAC, is being organised by Industrial Exhibitions Limited, 9 Argyll Street, London, W1, and will be held at Olympia, London, W14, from 26 September to 6 October, 1961.

The Institution of Heating and Ventilating Engineers, who are sponsoring HEVAC, have now decided that it would be of considerable benefit to the industry as a whole if their projected International Conference on Heating, Ventilating and Air Conditioning were to take place at approximately the same time as the exhibition, and at the same venue, because it was felt that many visitors to the exhibition, especially those coming from abroad, would wish to support the conference, and vice versa. The Institution are accordingly making arrangements for the conference to be held at Olympia from 27 September to 4 October, 1961.

It is the Institution's intention that the conference, the first of its kind to be staged in this country, shall be a really noteworthy event and that the highest standards shall be obtained in the planning of the papers, the authority of their authors and the arrangements for the comfort of the delegates. The Institution have devoted a thousand pounds towards the expenses of the conference organisation and an appeal has been made to manufacturers and contractors in the industry to provide working capital in the form of interest-free loans, half of which, it is suggested, should form a guarantee fund against loss.

The address of the Institution is 49 Cadogan Square, London, SW1. Telephone: SLOane 3158.

Mechanical Engineering in Data Processing

AN INFORMAL discussion on "The Reliability of Mechanical Engineering Parts of Data Processing Systems" is to be held on 5 January next, commencing at 10.30 a.m. The meeting is being organised by the Industrial Administration and Engineering Production Group of the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1, and will be held at that address.

This discussion may be regarded as the sequel to the one which was held recently in respect to the computer in production. Whereas, however, attention was previously directed to the underlying principles of computer application and operation, the emphasis at the forthcoming meeting will be placed upon mechanical construction and reliability, and upon features of design and manufacture of particular importance to the accurate and continuous operation of such equipment.

It is anticipated that realistic data on maintenance and comparisons between the performance of electrical and mechanical constructions will be made available. Peripheral equipment, without which computers would be comparatively useless for business purposes, will also be a prominent feature of the programme.

In the early stages, the peripheral equipment with which computers were required to work was based upon modified designs of established office machinery. Although such equipment was admirably suited to its original purpose, it was soon recognised that some fundamental developments were required in this connection if the potentialities of the computer were to be fully exploited, especially in respect of speeds of operation. The meeting will provide an opportunity of discussing the existing limitations of a mechanical character and means of overcoming them.

Speakers will represent both users and manufacturers, and sessions will be held in the afternoon and evening of 5 January, as well as in the morning. Requests for further information and applications to attend should be sent to the secretary, Institution of Mechanical Engineers, at the above-mentioned address. Telephone: WHItehall 7476.

European Approach to Space Technology

WITH the primary intention of bringing together engineers and scientists from Western Europe for discussions on the possibility of formulating a joint programme of space research, the British Interplanetary Society are organising the First European Symposium on Space Technology. The conference is due to be held in London from 26 to 28 June, 1961, inclusive.

Countries in Western Europe may participate in the symposium and a special invitation is extended to countries belonging to the Organisation for European Economic Cooperation. It is also envisaged that Commonwealth countries, particularly Canada and Australia, will take part in the programme. The conference will pay considerable attention to the situation in heavy industry and will discuss the most promising lines of approach, having regard to the resources of men and materials available to the participating nations.

Finance and organisation will be dealt with, in addition to the purely scientific aspects, and it is hoped that this will lead to final decisions and recommendations being reached for future consideration.

The address of the British Interplanetary Society is 12 Bessborough Gardens, London, SW1 (telephone: TATe Gallery 9371), from which further information can be obtained.

Exhibitions and Conferences

Plant Maintenance and Engineering Show, National.—Mon., 30 Jan., to Thurs., 2 Feb., 1961, in the International Amphitheatre, Chicago. Organised by Clapp and Poliak Inc., 341 Madison Avenue, New York 17, USA.

British Toy Fair, Eighth.—Mon., 30 Jan., to Fri., 3 Feb., 1961, at Mount Royal Hotel, Mostyn Hotel and the Mayfaria Rooms, all of which are in Bryanston Street near the Marble Arch, London, W1. Organised by British Toy Manufacturers' Association, Ltd., 93-94 Hatton Garden, London, EC1. Tel. CHAncery 9158.

Gifts and Fancy Goods Fair, Twelfth International.—Mon., 30 Jan., to Fri., 3 Feb., 1961, at Blackpool. Organised by Trade Promotion Services Ltd., Saint Dunstan's House, Carey Lane, London, EC2. MONarch 0871.

Furniture Exhibition, Twelfth Annual.—Mon., 30 Jan., to Sat., 11 Feb., 1961, at Earl's Court, London, SW5. Organised by B.F.M. Exhibitions Ltd., 17 Berners Street, London, W1. Tel. LANgham 5115.

Amusement Trades Exhibition.—Tues., 31 Jan., to Thurs., 2 Feb., 1961, at the Royal Horticultural Society's new hall, Greycoat Street, London, SW1. Organised by the Amusement Trades Exhibitions Ltd., 19 Charing Cross Road, London, WC2. Tel. WHItehall 2524.

Hotel, Restaurant and Institutions Exhibition, National.—Tues., 31 Jan., to Fri., 3 Feb., 1961, at the Show Mart, Montreal. Organised by the Hotel and Restaurant Suppliers Association, Inc., 1638 Sherbrooke Street West, Montreal, Canada.

Hardware Trades Fair, International.—Mon., 6 Feb., to Fri., 10 Feb., 1961, at Olympia, London, W14. Organised by Universal Exhibitions Ltd., 74 Holland Park, London, W11. Tel. PARk 7360.

Nylon Fair, British.—Mon., 6 Feb., to Fri., 10 Feb., 1961, at the Royal Albert Hall, London, SW7. Sponsored by British Nylon Spinners Ltd. Open to the trade only. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Swedish Boat Show.—Thurs., 9 Feb., to Sun., 19 Feb., 1961, in Gothenburg. Organised by A.B. Svenska Batutstallningen, 9 Kristellvagen, Hagersten, Sweden.

Agriculture and Agricultural Exhibition, 41st International.—Sun., 12 Feb., to Sun., 19 Feb., 1961, in Brussels. Apply to the secretariat-general, Salon de l'Agriculture, 29 Rue de Spa, Brussels, Belgium.

Leather Goods Industries Fair, Ninth.—Mon., 13 Feb., to Fri., 17 Feb., 1961, at Mount Royal Hotel, Marble Arch, London, W1. Further information from the exhibition section, *Leather Goods* Trade Journal, 15 Cursitor Street, London, EC4. Tel. CHAncery 4001.

Scottish Dairy Show.—Tues., 14 Feb., to Fri., 17 Feb., 1961, at the Kelvin Hall, Glasgow. Organised by the Scottish Agricultural Society, 82 Gordon Street, Glasgow, C1.

Radio and Electronic Components Show, Fourth International.—Fri., 17 Feb., to Tues., 21 Feb., 1961, in Paris. Organised by the Salon International des Fabricants de Piéces Detachées Radio et Electriques, 23 Rue de Lubec, Paris 16e.

Boat Show, International.—Fri., 17 Feb., to Wed., 22 Feb., 1961, at Dinner Key Auditorium, Miami. Organised by the Miami International Boat Show, Inc., 1333 Miami Avenue, Miami 32, Florida, USA.

Chicago Automobile Show.—Sat., 18 Feb., to Sun., 26 Feb., 1961, at McCormick Place, Chicago. Organised by the Chicago Automobile Trade Association, 35 E. Wacker Drive, Chicago 1, Illinois, USA.

American Concrete Institute, 57th Annual Convention.—Mon., 20 Feb., to Thurs., 23 Feb., 1961, at the Chase Park and Plaza Hotels, St. Louis, Missouri, USA. Institute offices: PO Box 4754, Redford Station, Detroit 19, Michigan, USA.

Display Market Week, Fourth.—Mon., 20 Feb., to Thurs., 23 Feb., 1961, at the Russell Hotel, Russell Square, London, WC1. Organised by the National Display Equipment Association, 2 Caxton Street, London, SW1. Tel. ABBey 4813.

Stationery Trades Fair, Seventh.—Mon., 20 Feb., to Fri., 24 Feb., 1961, at Alexandra Palace, London, N22. Organised by the Stationers' Association of Great Britain and Ireland, 6 Wimpole Street, London, W1. Tel. LANgham 9256.

Semiconductor Devices, International Convention.—Mon., 20 Feb., to Sat., 25 Feb., 1961, in Paris. Organised under the sponsorship of the Fédération Nationale des Industries Electroniques on the occasion of the 24th exhibition of producers of component parts and accessories. Apply to the secretariat of the Société des Radioélectriciens, 10-14 Avenue Pierre-Larousse, Malakoff (Seine), France.

Higher Management, Course for.—Mon., 20 Feb., to Fri., 3 Mar., 1961; and Mon., 13 Mar., to Fri., 17 Mar., 1961, at Dunford College, near Midhurst, Sussex. Inquiries should be made to offices of Associated Industrial Consultants Ltd., or to the AIC College of Management, 54-58 Uxbridge Road, London, W8. Tel. EALing 4567.

Cycle and Motor Cycle Exhibition, International.—Thurs., 23 Feb., to Sun., 5 Mar., 1961, in Amsterdam. Organised by the Nederlandsche Vereeniging de Rijwiel en Automobiel Industrie, 13 de Lairessestraat, Amsterdam, Netherlands.

Household Goods and Hardware Fair.—Fri., 24 Feb., to Mon., 27 Feb., 1961, in Cologne. Inquiries in the United Kingdom should be sent to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Toy Fair, International.—Sun., 26 Feb., to Fri., 3 Mar., 1961, in Nuremburg, Germany. Organised by Spielwarenmesse e G.m.b.H., 24 Berliner Platz, Nuremburg. United Kingdom inquiries should be sent to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Gift Show, New York.—Sun., 26 Feb., to Fri., 3 Mar., 1961, at the Hotel New Yorker and the Trade Shows Building, New York. Organised by Little Brothers Inc., 220 Fifth Avenue, New York 1, USA.

Smallwares Trade Fair.—Mon., 27 Feb., to Fri., 3 Mar., 1961, at the Queen's Hotel, Hastings. Organised by Trade and Technical Exhibitions,

1 Dorset Buildings, Salisbury Square, London, EC4. Tel. FLEet Street 1555.

Carpet Production Exhibition.—Mon., 27 Feb., to Fri., 3 Mar., 1961, at Earl's Court, London, SW5. Covers machinery, equipment and accessories. Held in conjunction with the International Carpet Linoleum and Floor Coverings Fair. Open to the trade only. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Carpet, Linoleum and Floor Coverings Fair, International.—Mon., 27 Feb., to Fri., 3 Mar., 1961, at Earl's Court, London, SW5. Sponsored by official trade associations. Open to the trade only. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Household Textiles and Soft Furnishings Fair, Eighth National.—Mon., 27 Feb., to Fri., 3 Mar., 1961, at Earl's Court, London, SW5. Open to the trade only. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Men's and Boys' Trade Fair, International.—Mon., 27 Feb., to Fri., 3 Mar., 1961, at Earl's Court, London, SW5. Open to the trade only. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Objective and Subjective Requirements for Loud Speakers," by F. H. Brittain. Electro-Acoustics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Tues, 13 Dec., 6.30 p.m.*

LIVERPOOL
"Very-High-Frequency Sound Broadcasting," by L. G. Dive. Merseyside Section. Adelphi Hotel, Liverpool. Wed., 14 Dec., 7 p.m.

SOUTHAMPTON
"Some New Piezo-Electric Devices," by A. E. Crawford. Southern Section. Lanchester Building, The University, Southampton. Wed., 14 Dec., 7 p.m.

Combustion Engineering Association

LONDON
"Standards of Boiler Instrumentation": Discussion, to be opened by R. P. Braby. Southern Region. Criterion Restaurant, Piccadilly Circus, W1. Tues., 13 Dec., 10.30 a.m.

Diesel Engineers and Users Association

LONDON
"Report on Diesel Engine Working Costs and Performance, 1959-60." Discussion. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 15 Dec., 2.30 p.m.

Illuminating Engineering Society

LONDON
"Visual Problems on Motorways," by J. M. Waldram. Federation of British Industries, 21 Tothill Street, SW1. Tues., 13 Dec., 6 p.m.

SHEFFIELD
"Chance and Vision," by D. L. Smare. Sheffield Centre. Grand Hotel, Sheffield. Wed., 14 Dec., 6.30 p.m.

Institute of Marine Engineers

LONDON
"Details and Operating Data of Recent Alternating-Current Installations," by A. N. Savage. Tues., 13 Dec., 5.30 p.m.*

BRISTOL
"Heatless Repairs to Fractured or Broken Castings," by N. Tinwell (with film). West of England Section. Small Engineering Lecture Theatre, The University, University Walk, Bristol 8. Mon., 12 Dec., 7.30 p.m.

Institute of Metals

GLASGOW
Film Display. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Mon., 12 Dec., 6.30 p.m.*

Institute of Road Transport Engineers

LONDON
"Wear and Tear" (Part II), by J. E. Johnson. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 15 Dec., 6.30 p.m.

GLASGOW
"Some Aspects of the Factories Acts in Relation to Road Transport Operation," by C. R. Noble. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Mon., 12 Dec., 7.30 p.m.

HOVE
"Measurements in Engine Development," by B. W. Millington. Southern Centre. Palmeira Hotel, Hove. Wed., 14 Dec., 7.30 p.m.

LEEDS
"Design and Construction of the Routemaster Bus," by A. G. Higgins. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 15 Dec., 7.30 p.m.

LIVERPOOL
"Road Safety," by J. W. Todd. North Western Centre. Merton Hotel, Merton Road, Bootle, Liverpool 20. Wed., 14 Dec., 7.30 p.m.

Institution of Civil Engineers

LONDON
"The Design, Construction and Operation of the Middle Lee Regional Drainage Scheme," by D. R. Balfour, H. D. Manning, T. Cripps and E. A. Drew. Tues., 13 Dec., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Electrical Engineering in the Naval Service": Address by the President, Sir Hamish D. MacLaren. London graduate and and Student Section. Tues., 13 Dec., 6.30 p.m.*

EDINBURGH
"Energy Resources of Scotland," by J. Henderson and C. L. C. Allan. South East Scotland Sub-centre. Carlton Hotel, North Bridge, Edinburgh. Tues., 13 Dec., 7 p.m.

GLASGOW
"Protection of Electrical Systems," by H. G. Bell. Second Hunter Memorial Lecture. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 14 Dec., 6 p.m.*

MANCHESTER
"Pharmacology of the Mind," by Professor A. D. MacDonald. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 13 Dec., 7 p.m.

NEWCASTLE UPON TYNE
"Street Lighting," by W. R. Stevens; and "A Survey of Street Lighting and Its Future," by W. R. Stevens and H. M. Ferguson. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 12 Dec., 6.15 p.m.*

Institution of Engineering Designers

BRADFORD
Film Evening. Yorkshire Branch. Midland Hotel, Bradford. Wed., 14 Dec., 7.30 p.m.

Institution of Engineers-in-Charge

LONDON
"Site Welding of High-Pressure Steam-Raising Plant," by J. Strevens. Caxton Hall, off Victoria Street, SW1. Wed., 14 Dec., 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Developments in Marine Steam Turbine Design," by Dr. T. W. F. Brown. Joint meeting with the Scottish Section of the Institute of Marine Engineers and the Greenock Association of Engineers and Shipbuilders. Tues., 20 Dec., 6.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Maximum Cylinder Pressure Fluctuations in a Petrol Engine," by J. P. Soltau. Automobile Division. Tues., 13 Dec., 6 p.m.*
"Machine Tool Research, Design and Utilisation," by Dr. D. F. Galloway. James Clayton Lecture. Wed., 14 Dec., 6 p.m.*
"The Impact of a Three-Fuel Economy": Discussion. Nuclear Energy Group. Thurs., 15 Dec., 6 p.m.*

BELFAST
"The Inspection of the Primary Circuits and Reactor Pressure Vessels of Nuclear Power Plant," by H. N. Pemberton and H. Crossley. Northern Ireland Branch. Central Hall, College of Technology, Belfast. Tues., 13 Dec., 6.45 p.m.*

LEEDS
"Some Developments in the Nuclear Field," by Dr. A. T. Bowden. Yorkshire Branch. The University, Leeds. Thurs., 15 Dec., 6.30 p.m.

NEWCASTLE UPON TYNE
"Power Flow and Pressure Measurement in Pump Testing," by Leslie Young and F. Nixon. North Eastern Branch. Stephenson Building, Claremont Road, Newcastle upon Tyne. Thurs., 15 Dec., 6.15 p.m.

READING
"The Small Diesel Engine for Cars," by H. H. Howarth and C. J. Walder. Southern Branch. Offices of Huntley and Palmers Ltd., King's Road, Reading. Wed., 14 Dec., 7.30 p.m.*

SWANSEA
"Planned Maintenance," by T. G. Elgie. South Wales Branch. Offices of the South Wales Electricity Board, Kingsway, Swansea. Tues., 13 Dec., 6 p.m.

Institution of Mining and Metallurgy

LONDON
"Recovery of Cassiterite at the Sungei Besi Mines, Selangor, Malaya," by H. Dalton-Brown; and "Recovery of Fine Alluvial Cassiterite: Correlation of Bore Valuations with Plant-Scale Recovery," by F. A. Williams. Geological Society, Burlington House, Piccadilly, W1. Thurs., 15 Dec., 5 p.m.*

Institution of Plant Engineers

BLACKBURN
"Measurement of Gas," by A. C. Smith. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 15 Dec., 7.30 p.m.

BRISTOL
"Use of Plastics in Engineering": Discussion. Western Branch. Grand Hotel, Broad Street, Bristol. Wed., 14 Dec., 7.15 p.m.

MANCHESTER
"Industrial Water," by W. K. Lewis. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 13 Dec. 7.15 p.m.

Institution of Production Engineers

LEEDS
"Statistics as an Aid to Production Engineers," by C. Loveluck. Leeds Section. Hotel Metropole, King Street, Leeds 1. Mon., 12 Dec., 7 p.m.

READING
"Electronic Data Processing Allied to Production Engineering," by F. W. Purchall. Reading Section. George Hotel, King Street, Reading. Thurs., 15 Dec., 7.30 p.m.

SHEFFIELD
"British Railways' Welding of Railway Rolling Stock," by G. Walton. Sheffield Section. Grand Hotel, Sheffield. Mon., 12 Dec., 7.15 p.m.

Institution of Public Health Engineers

LONDON
"Environmental Dispersion of Radioactive Wastes," by J. C. Collins. Caxton Hall, off Victoria Street, SW1. Thurs., 15 Dec., 6 p.m.

Institution of the Rubber Industry

LONDON
"Some Radiation Effects on Rubbers," by E. E. Gunn, at 5.30 p.m.; and "Competitive Polymers in Automobile Applications": Discussion, at 7 p.m. Royal Overseas League, Park Place, St. James's, SW1. Tues., 13 Dec.

MANCHESTER
"V-belts: Manufacture, Performance and Future Developments," by T. Hall. Manchester Section. Engineers' Club, Albert Square, Manchester. Mon., 12 Dec., 6.45 p.m.

Junior Institution of Engineers

LONDON
"The Development Engineer in the Petroleum Industry": Presidential Address, by E. S. Sellers. Fri., 16 Dec., 7.30 p.m.*

Leeds Metallurgical Society

LEEDS
"Metals and Alloys Used in the Jewellery and Silverware Industries," by Miss D. Pile. University Staff House, University Road, Leeds. Tues., 13 Dec., 6.30 p.m.*

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"The Institution," by T. S. Nicol. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 16 Dec., 6.15 p.m.

Pipeline Industries Guild

LONDON
"Construction of the M.1 Motorway," with film, by J. J. G. Michie. Caxton Hall, off Victoria Street, SW1. Tues., 13 Dec., 6.30 p.m.

Royal Meteorological Society

LONDON
"Automatic Methods of Handling Meteorological Data": Discussion to be introduced by A. L. Maidens. Wed., 14 Dec., 2.30 p.m., to 6.30 p.m.*

Royal Society of Arts

LONDON
"Function of Trade Unions in Industry and Commerce," by W. J. Carron. Wed., 14 Dec., 6 p.m.

Royal Statistical Society

LONDON
"Operational Research and Statistics: A Comparison and a Criticism," by B. H. P. Rivett. Royal Institute of Public Health and Hygiene, 28 Portland Place, W1. Tues., 13 Dec., 6.15 p.m.*

Royal United Service Institution

LONDON
"A Critical Appraisal of the North Atlantic Treaty Organisation," by General Sir Richard N. Gale. Wed., 14 Dec., 3 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Spalling from First Principles," by J. F. Clements. Refractories Group. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 13 Dec., 7.30 p.m.

Society of Instrument Technology

LONDON
"Speed Control of Aircraft Gas Turbines for Jet Propulsion," by R. J. Walsh and R. W. Haigh. Manson House, 26 Portland Place, W1. Wed., 14 Dec., 7 p.m.,.*

CHELTENHAM
"Automatic Transmission," by E. Nichol. Cheltenham Section. Belle Vue Hotel, Cheltenham. Wed., 14 Dec., 7.30 p.m.

South Wales Institute of Engineers

CARDIFF
"Experiments in South Wales with an Instrumented Coal Plough," by L. Finkelstein and others. Thurs., 15 Dec., 6 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Recent Developments in Refractories for Iron and Steel Making," by R. Malcolm. Fri., 16 Dec., 6.45 p.m.

Women's Engineering Society

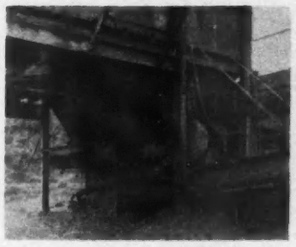
LONDON
"Power Transmission by Submarine Cable," by Captain F. Potts. Hope House, 45 Great Peter Street, SW1. Wed., 14 Dec., 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Public Health Engineers, 179–181 Vauxhall Bridge Road, London, SW1. (VICtoria 3017)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289)
Pipeline Industries Guild, 7 Iddesleigh House, Caxton Street, London, SW1. (ABBey 6925)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Royal United Service Institution, Whitehall, London, SW1. (WHItehall 5854)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

AGGREGATE MIXER

Variable Speed Motors



VARIABLE speed motors with remote control have now been introduced into the Blender volumetric feeder system.

Four of the units are shown in the illustration. The material is stored in hoppers above the feeder belt and falls by gravity through an adjustable gate. Rotating paddles are used to control the flow which may be continuous or intermittent. The materials can be supplied in any proportions.

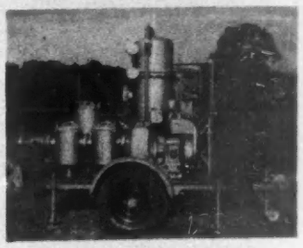
The units can be mounted singly or in banks either beneath, as shown, or at the side of the aggregate bins. Combinations of speed and door settings provide a range of outputs from 5 to 200 tons per hour from one Blender. The full range variable speed drive with remote control is a development of the speed change feature of earlier models. It entirely eliminates the need for resetting doors for mixture changes and gives finger-tip operation.

On the control desk are a speed indicator dial (calibrated from zero to 100) for each Blender; a preset dial (0 to 100 per cent); a selector switch for each Blender and a preset operation timer. When installed, all the doors are set to deliver the same tonnage during a given period.

In operation, the attendant turns the presetting dials to the percentage required from each feeder and all will then run concurrently at their different speeds delivering a proportion of the total batch during the same period of time, and then stop simultaneously. A second batch of the same proportions can be obtained simply by pressing the start button. *Frederick Parker Limited, Leicester.*

WATER PURIFIER

Mobile Unit



RAW water can be fully treated by a mobile unit that has recently been introduced.

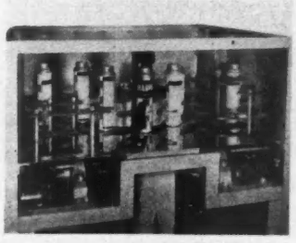
The equipment incorporates a Diafilter type C55 using the diatomaceous earth principle. This provides a considerable water flow in relation to moderate space requirements and constitutes a method of filtration of extremely high efficiency. Pumping is by an Alcon centrifugal pump driven by a Petter diesel engine. Various modifications can be incorporated; for example, gas chlorination can be substituted for sodium hypochlorite dosing, and a petrol engine for the diesel.

The Scottern 1½ ton trailer has autolock coupling, hand and power brakes, hand steering, and corner jacks. The floor is made of Iroko boards with jointed interlock. The filter has a capacity of 6,600 gallons per hour at optimum flow rate of 2 gal per sq. ft per min, and is fitted with coarse and fine strainer units. There is a quick release drain valve, twin gauges for differential measurement, and a pre-coat pot for diatomaceous earth recharging. A vacuum gauge is fitted in the suction line of the plant.

A Wallace and Tiernan reagent feeder is belt driven from the engine shaft at 300 r.p.m. and has a maximum capacity of 50 gal of sodium hypochlorite per 24 hours. The range is adjustable by 36 to 1 by varying the stroke length and the number of strokes per minute. The type AVA1 engine develops 6 b.h.p. at 1,800 r.p.m. and the Alcon pump has a capacity of 9,000 gal per hour giving it a comfortable capacity margin. *Gilliam and Company Limited, Purley Way, Purley, Surrey.*

CHECK WEIGHER

For Packaged Goods



PACKAGED goods can be checked for weight at high speed on the Automa check weigher.

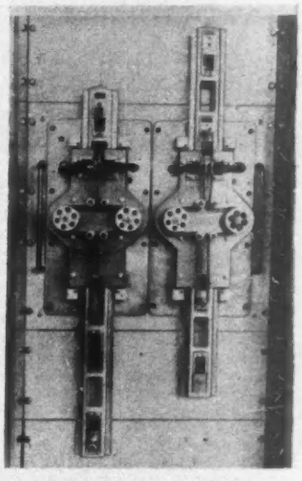
A typical installation of this electronic machine is capable of checking filled cans at rates up to 200 per minute. The weighing system, which has passed Board of Trade tests, can maintain an accuracy of ± ½ per cent of the set figure. The standard machine will handle cans up to 3 in diameter and up to 18 oz in weight. It requires very little floor space: 36 in by 28 in for the machine itself and 22 in by 12 in for the electronic control unit. The conveyor level is adjustable from 34 in to 38 in above ground level. Speed of operation is largely dependent on the ratio of diameter to height of the cans.

Cans are delivered to the machine on a cotton faced belt with a star wheel infeed. An eight station turret passes them to the weighing station where the clamping arm releases each can on to the grid where its stands freely during the actual measurement. Afterwards the grid lifts the can back to the turret.

Underweight cans are released at the reject station by a signal transmitted to the turret by the weigher. Correct weight cans go to the accept station where they are released automatically. Parallel belts carry the two lines away from the machine, the accept belt being in line with the infeed. The handling system is cam controlled and is independent of the weighing system. No attendant is required as the operation is fully automatic. Star wheels and guides are quickly changeable for cans of different size. A drive cut-out is incorporated for protection against damaged cans. *Elliott-Automation Limited, 34 Portland Place, London, W1.*

TAPE TRANSPORT

Discrete Steps



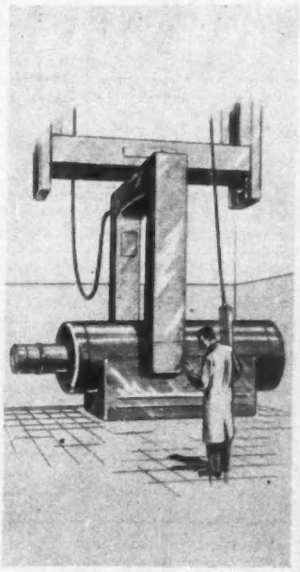
A RECENT design of magnetic tape transport mechanism moves the tape forward in small separate steps instead of continuously.

The mechanism is intended for inclusion in data recording equipment and permits controlled variations to be made independently in the speed of recording data and the speed of reading data. Controlled variations can also be made in the time delay produced by the passage of data from the recording heads to the reading heads.

Two transports are used in the equipment using 35 mm tape with sprocket holes. Up to 1,000 ft of tape can be stored on reels, or the tape can be in a continuous loop up to 40 in long as shown in the illustration. The forward movement is carried out by a stepping motor actuated by successive electrical impulses, with a speed reduction gear between it and the sprocket system. The tape movement has high acceleration and deceleration so that the main advance is at constant speed. The interval of uniform forward motion coincides with the recording or read-out period of the element of data. *Redifon Limited, Gatwick Road, Crawley, Sussex.*

X-RAY SOURCE

Thick Plate Inspection



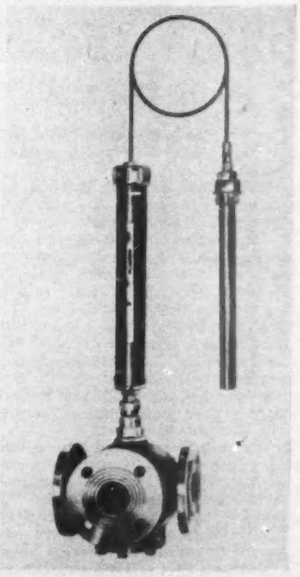
A LINEAR accelerator now being built for the A. O. Smith Corporation can produce radiographs of steel 11 in thick in 1 minute.

The operating head of the Linac will be 11 ft long and 30 in diameter with a 12 in radiation aperture. At 8 MeV the intensity of radiation will be 6,000 R per minute. There is a choice of 1 mm or 5 mm focal spot sizes, with respective outputs of 1,500 R and 6,000 R per minute. At full power using the 5 mm spot it takes 1 minute to photograph through 11 in of steel or 16 in in about 18 minutes. The 1 mm spot gives better resolution taking 1 minute for 8 in thick steel or 30 minutes for 14 in.

The operating head will be suspended from a crane allowing height adjustments up to 16 ft above floor level and tilting to vertically downward or 45° upward. Interlocks prevent it from being pointed at the room entrances and from being operated if the doors are open. *High Voltage Engineering Corporation, Burlington, Mass., USA.*

TEMPERATURE REGULATOR

Direct Acting



NOW available in this country is the range of temperature regulators made by Odin Clorius A/S.

These are direct-acting instruments working on the expansion of a liquid, usually glycerine. The liquid works against a piston in the adjusting cylinder and the piston directly determines the position of the valve cone. The regulator is set at the desired temperature by turning the handle on the adjusting cylinder. A powerful safety spring ensures that the apparatus is not damaged if dirt comes into the valve.

The feeler is normally made of copper but can be supplied in stainless steel if required. The regulator can be supplied with bronze valves having screwed connections for pressures up to 30 lb per sq. in; with cast iron valves up to 195 lb per sq. in or cast steel valves working up to 375 lb per sq. in. The illustration shows one fitted to a mixing valve for hot water. *Automa Engineering Group Limited, Cherry Tree Rise, Buckhurst Hill, Essex.*

FACE CONVEYOR

Hydraulic Powered

It is claimed for a hydraulically driven face conveyor that it is smaller in size and requires less floor space than pneumatic versions.

The Armadillo is such a conveyor for the mining industry. The transmission is obtained by circulating oil from a pump to a motor of identical design using a closed system. A stop-start-reverse valve controls the operation and it is claimed that the conveyor can be stopped within 2 ft of travel from full speed. The pumping set can be as much as 100 yards from the conveyor itself.

Four pumps are used to drive one hydraulic motor, their outputs being brought into the feed line in pairs so that the oil is accelerated in two stages. This also allows the motor to be run at two speeds. The power pack consists of a 250 gallon steel tank fitted with wheels suitable for running on the tub track. The size allows for cooling and oil running back from the pipe lines when the gate is rising to the face. Full flow filters are fitted in wells at the bottom of the tank and baffles provided to circulate the oil round a long path to dissipate its heat through the sides and top of the tank. An oil cooler is also fitted.

On the same track adjacent to the tank are fitted the pump bogies, one at the front and one behind. Each consists of a double pump unit, each pump having an output of 28 g.p.m. Mounted at the rear of the set is a pilot pump of 4 g.p.m. capacity. All the pipes between the tank and the bogies are flexible. Apart from the saving in space, it is claimed that the machine is quiet in operation and has no exhaust vapours as is the case in the pneumatic version. The same degree of visibility is obtained as with electric motors, and the air compressor is eliminated. The machine requires only 35 sq. ft of floor area allowing prop setting of 5 ft 4 in centres. *Richard Sutcliffe Limited, Horbury, Wakefield, Yorkshire.*

DUMPER

25,000 lb Payload

The F7 dumper has been produced to fill the gap between the 3 to 4 and 10 to 15 cu. yd ranges.

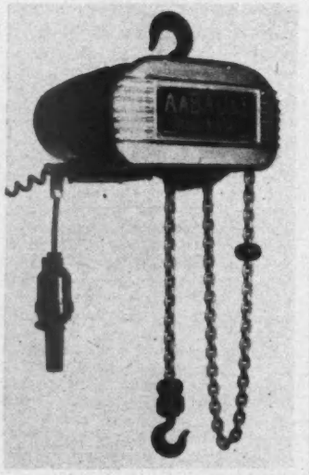
It has a payload of 25,000 lb and the large spotting area of the hopper (8 ft by 10 ft) makes for quick loading. Double-acting hydraulic rams effect a total tip of 78° in 7 seconds. The return to carry position takes 5 seconds and can be accomplished while the dumper is driving away. The weight distribution is placed well forward—it is claimed that never less than 55 per cent is over the final drive—so steering and traction are good whether the vehicle is loaded or empty.

Power is supplied alternatively by a Perkins S6 or a Ford 6D engine driving through a Brockhouse torque converter. This gives an automatic variable speed ratio between 6·5 to 1 and 1 to 1 in two forward speeds, and a reverse ratio of between 6·5 to 1 and 2 to 1. The overall reduction through the final drive is between 121 to 1 and 19·5 to 1. Acceleration is said to be good and the vehicle can climb gradients steeper than 1 in 4. Disc transmission parking brakes are incorporated with the final drive.

The steering is power-assisted and the articulation, which will give 90° on full lock, allows a turning circle of 18 ft 9 in, less than the length of the machine itself. It is claimed that the centre of gravity is low and that it is virtually impossible to overturn the vehicle while dumping. The four wheels are interchangeable and can be differently tyred so that they will grip under all conditions. The hydraulic pump is housed in the final drive unit. *Northfield Industrial Fabrications Limited, Langley Mill Works, Ossett, Yorkshire.*

CHAIN BLOCK

Electric Operation



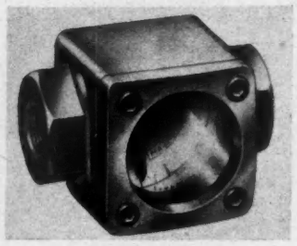
The Powerlift is an electrically operated chain block with a safe working load of 1 ton.

The standard model as shown in the illustration is fitted with hook suspension and therefore can be used in most convenient positions. If required, travelling carriages can be fitted instead, for hand or power travel. The block requires a headroom from hook to hook of 20 in and has an overall length of 19 in. The depth from front to rear is 21 in and from front to hook centre line is 8 in. It is supplied with 12 ft of lifting chain as standard, but additional chain can be fitted if desired. The load hook is made of drop forged steel and is fitted with a ball bearing swivel.

The block is controlled by one hand using the watertight Bakelite push button pendant, which is suspended by a tough rubber or pvc sheathed cable. The motor is totally enclosed and the brake is of patented design. There are automatic limit switches for hoisting. Speeds of hoist are up to 20 ft per minute and when electric travel is included the speed may be either 60 or 120 ft per minute. *Aabacas Engineering Company Limited, Birkenhead.*

FLOW INDICATOR

Opaque Fluids



Flow indicators now on the market are designed to show the flow of opaque fluids.

The Magnetal range can be used with fluids of almost any viscosity, including very thick oils, and are equally suitable for showing flows either horizontally or vertically upwards. As the fluid travels through the chamber of the indicator it moves a hinged metal flap which incorporates a set-in magnet to operate a pointer against a scale. As there are no springs or other moving parts, the risk of mechanical breakdown or jamming is eliminated, and the pointer and scale are in a separate chamber so that the fluid cannot obscure the window.

Internal parts of the Magnetel are readily accessible for cleaning while the body is still on the line, and can be turned through 90° if required to change the direction of flow. A particular feature is that the unit can be easily adapted for very low flow rates and, as the sensitivity is high, small changes are shown. It will also accept a wide range of capacities when the full flow is shown on the scale so that it is not damaged by overloads.

Where the fluid being handled is liable to contain magnetic particles, a special screened version is available in which the magnet is enclosed in an intermediate chamber. A model incorporating a switch is also made so that if the flow stops or falls below a certain figure remote indication is given. Sizes are available for ¼ in, 1 in and 1½ in pipes and are fitted with screwed connections as shown in the illustration. A 2 in size has flanged ends. *Sir W. H. Bailey and Company Limited, Albion Works, Patricroft, Manchester.*

TORCH

For Unsafe Atmospheres

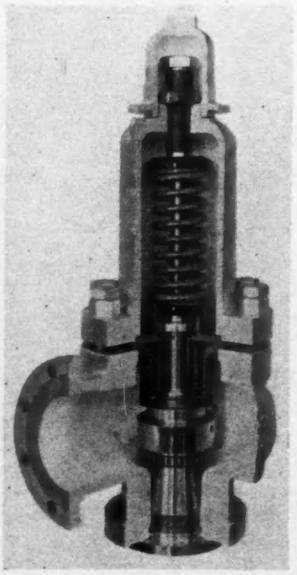
A new range of BM two-cell torches has been declared intrinsically safe for hydrogen, ethylene and pentane classes.

The switch is operated by rotating the head and is made with nylon insulation. In the Mark II model the head is only removable by using a special key. The whole of the exterior of the torch body is coated with nylon to prevent the possibility of spark generation if dropped or knocked.

Stringent tests have been carried out on these torches. One was switched on and off 500,000 times under water without visible signs of wear; it was left out in water and mud for several weeks and still operated correctly at the end. After 48 hours at a temperature of −20° F, operation was still normal after warming up. That it will withstand impact is proved by models that have been dropped from a car travelling at 50 m.p.h. on a made up road, and by dropping from a height of 15 ft on to concrete, both without affecting the operation. A three-cell version is also made and domestic models that do not have the protective nylon coating. *Bardic Limited, Northam, Southampton.*

RELIEF VALVE

Back-Pressure Balanced

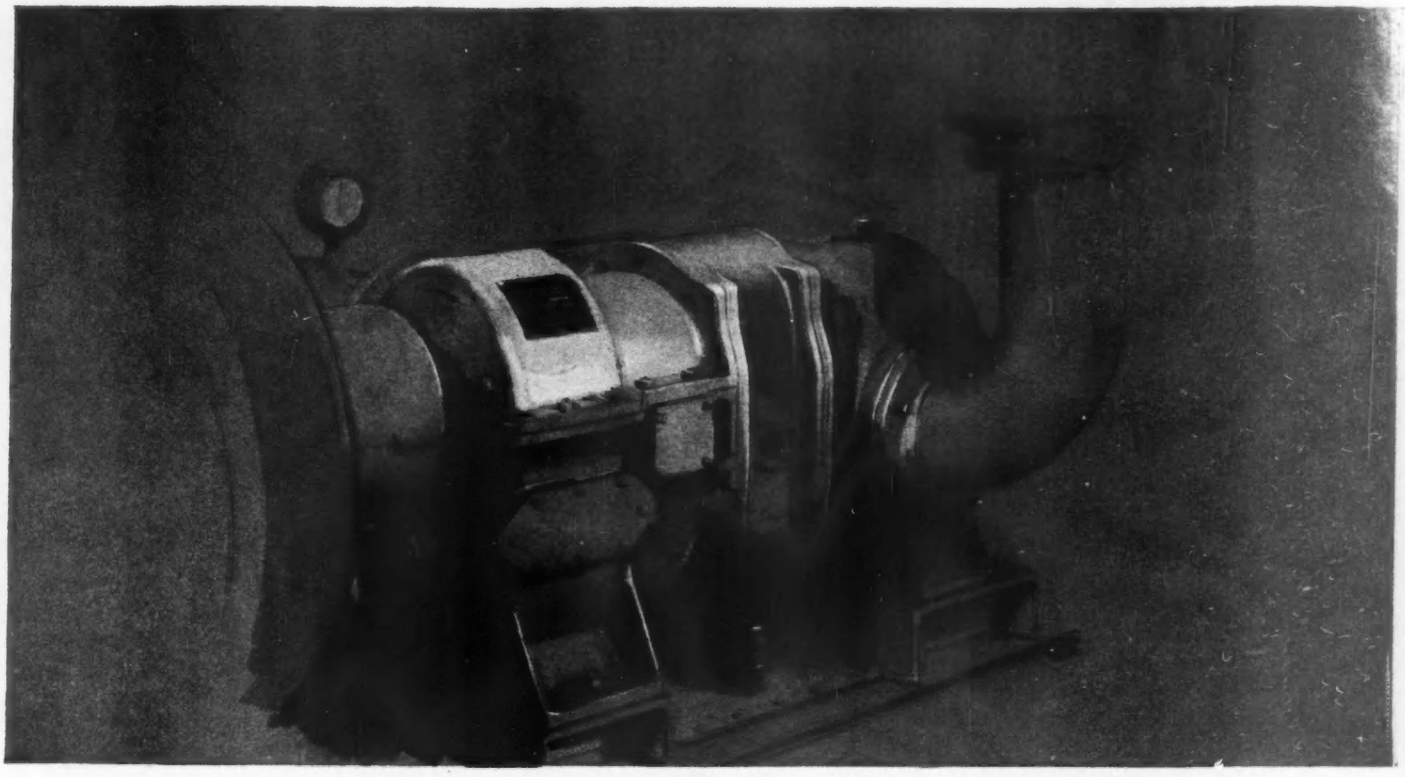


A new relief valve has been designed to be independent of back-pressure variations on the discharge side.

The valve, style JB-BP, combines the main features of the two existing methods of balancing against back pressures—those of the bellows seal and the piston balance.

With the balancing bellows seal, back-pressure effects are eliminated and no atmospheric vent is necessary. In the unlikely event of the bellows being ruptured the balancing is then taken care of by the piston, which is placed immediately above the bellows, thereby ensuring that the valve opening pressure still remains unaffected by the back pressure.

The valve retains various exclusive features of the firm's design such as the shield protecting the bellows from turbulent vibration effects during discharge, and the truly optically flat seats on both the nozzle and disc. *Crosby Valve and Engineering Company Limited, Crosby Works, Ealing Road, Alperton, Middlesex.*



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As rotary-screw compressors without any reciprocating parts they are fundamentally free from out-of-balance forces, with a large output in relation to their size. With their high speed and freedom from valves they give a pulseless delivery.

Accurate gearing maintains the rotors with a designed clearance; thus they never touch and are less affected by air-borne impurities. The rotors need no lubricant; the air or gas delivered is therefore oil-free, an advantage in certain industries and an economy in all.

Howden compressors are driven through Howden speed-increasing gearboxes from any suitable power source.

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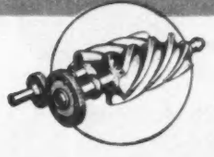

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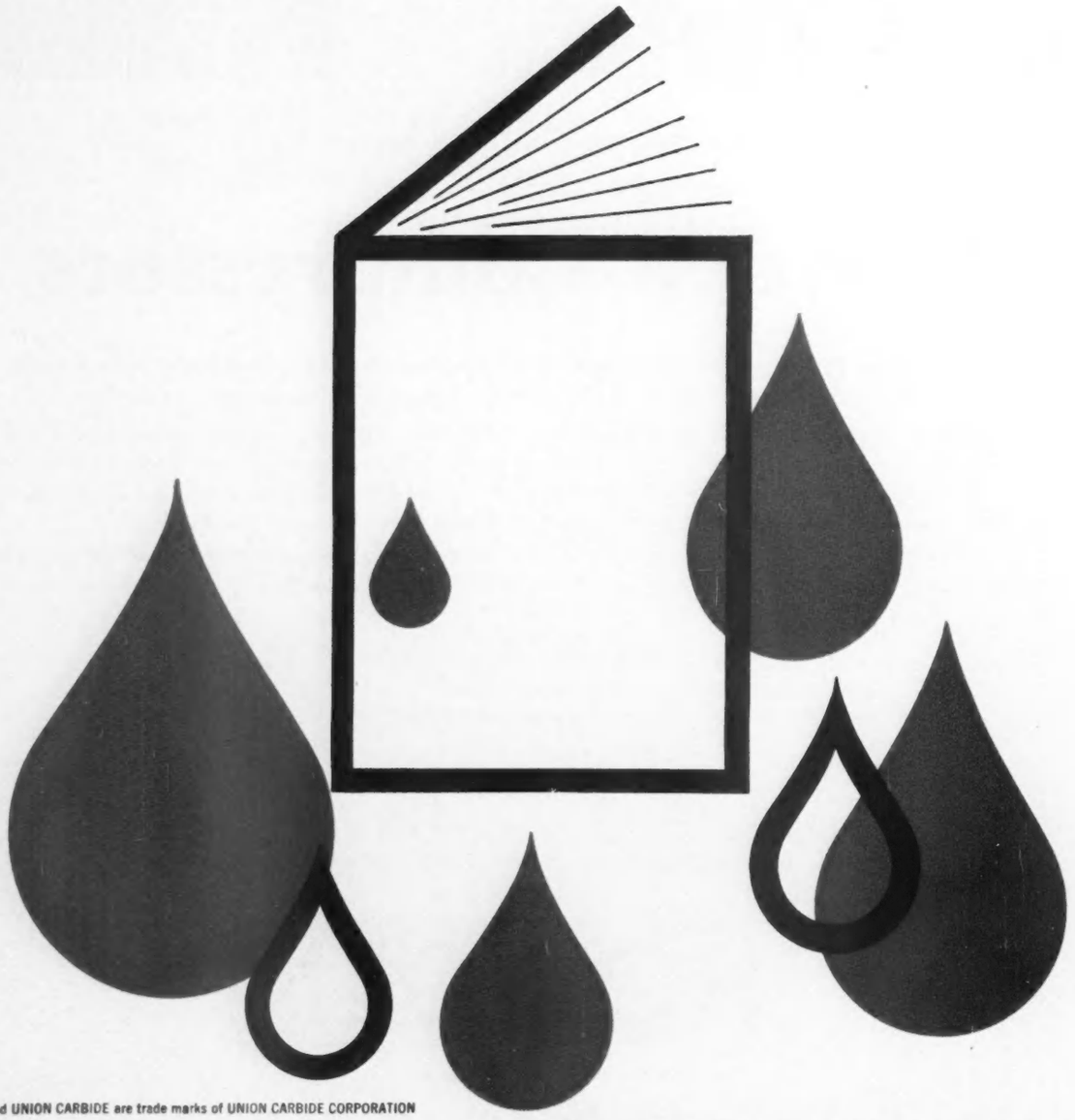

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CRC CL4

Human Element

Big Industrial Response to Anti-Polio Campaign

ONE of the most encouraging elements in the support for the anti-polio campaign, launched last month by the National Polio Vaccination Committee, is the way in which industrial firms have called on the committee for publicity material and advice on persuading their staffs to be vaccinated against polio.

Posters, wage packet slips and talks are being used in factories up and down the country to put across the message that adults as well as children should have themselves vaccinated.

The National Polio Vaccination Committee is an independent body numbering over 70 M.P.'s and supported by the Ministry of Health. The work so far done in mass vaccination, much of it among children, reduced the number of deaths from polio to 86 last year. One of the side effects of this was to take the danger of getting the disease out of the headlines.

In the age group 26 to 40 the rate of acceptance of vaccination has declined to as low as two per cent of the population in some counties.

Willing Help

For its day to day work the Polio Committee has not lacked for willing helpers. The British Safety Council offered office space in their London headquarters. Mrs. Patricia McLoughlin, MP for Belfast West, offered the free services of the public relations agency where she is a director.

The " Make a Call and Save a Life " appeal to members of the public to each telephone three friends and urge them to be vaccinated and to then ring three of their own friends is estimated to have already caused hundreds of thousands of calls to be made.

In many towns companies are arranging mass vaccinations for their employees.

The Polio Committee chairman, Sir Graham Rowlandson, has said: " It is the duty of every company director in this country to arrange a mass vaccination on his premises for the welfare of his employees.

" We cannot afford to slacken off our work until we bring across the purpose of the campaign to every member of the public."

Ford Shop Stewards Seek to Spread the Work

It is hard to see how the Ford company management at Dagenham could apply the shop stewards' suggestion that the work at the plant should be spread out to avoid the short time working of the 18,000 men on the car side of the business, now on a four-day week.

Commercial vehicle demand, at least in the export field, is still booming away and in this section of the Ford plant, as in some other firms, overtime is still being worked. On the face of it, to cut one man down to four days a week while another is working his full 41¼ hours and overtime as well is neither sympathetic nor economical.

But in practice spreading the work in the commercial vehicle section of the company's activity could only mean increasing the unit costs with potentially serious effects on sales at home and abroad.

In the same way the shop stewards' renewed demand for a 40-hour week, three weeks paid holiday in place of the present fortnight, and a general wage increase plus more annual bonus money are essentialy matters for a prosperous industry and not one whose troubles, even if they are believed to be temporary, are serious enough.

The shop stewards, who are to put their case to the management, agree with the employers in at least one matter. A resolution passed at a recent meeting called for an end to the credit squeeze.

Municipal Engineers' Reply to RIBA Proposals

The letter to local authorities from the President of the Royal Institute of British Architects in favour of creating new departments led by architects with the rank of Chief Officers has been followed by a letter to Town Clerks from the Institution of Municipal Engineers.

The Municipals, presenting the case for the present all-purpose departments, remind the local authorities that the vast majority of the technical work carried out in their name is engineering and surveying. With admirable objectivity, the Municipals leave it to the local authorities to consider whether the coordinating officer should be an engineer and surveyor or an architect.

The Municipals' Council point out that practically all councils are at present obtaining skilled architectural advice. They feel that the proposal, while its acceptance would enhance one particular profession, does not pay due regard to the facts in the situation.

Distinction, Economy

More than half of local authority building work is said by the Council of the Municipals' to be of an engineering character, not suitable to be designed and carried out by architects alone. Collaboration between architect and engineer is therefore necessary and the best way of handling the question is primarily one for the local authorities rather than for either profession.

Under the existing way of doing things, the Council recalls, local authority teams led by engineers have built more than 60 per cent of the 3½ million council houses and other buildings—" with distinction, business efficiency and economy."

Creation of independent architectural staff would involve the cooperation of two separate staffs, each under a Chief Officer. While the Council recognises that this works for certain of the very largest authorities, it feels it cannot be recommended for general adoption because of coordination difficulties and waste of time and money.

For economic and efficient local administration, the Municipals believe that the best method is a single coordinating department covering all building activities, including the engineering, architectural and planning aspects, controlled by a single Chief Officer with assistants of appropriate qualification.

In his letter to the councils, Sir William Holford, the RIBA President, put forward the view that if there were to be architect Chief Officers then better architects would enter local government. The other side of this penny, if it is valid, is that poorer engineers would accept jobs in a team headed by an architect.

The Municipals are in something very like head-on collision with the RIBA when their letter says that, while the latter has drawn attention to the number of authorities who have created separate departments, it has not pointed out the numbers who, having done so, are disappointed with the results and have either wholly or partly abandoned the experiment.

Untypical London

Plainly enough the position of the London Council Council is unique. With income and responsibilities greater than many of the States sitting at the United Nations, it provides no parallel at all for an average authority with between 40,000 or 100,000 people to cater for, with all its engineering, structural work, architecture and planning under the control of the Engineer and Surveyor.

On the achievements of the Ministry of Education's team of architects, the Municipals point out that the example of large scale central Government direction of architectural work is available to every local authority without regard to the way their architectural work is organised. Equally, the work of architects on cost study and increasing efficiency are available to all architects however employed.

The Municipals conclude their letter to Town Clerks by denying any intention to decry the professional work of a sister profession. The very capable architects departments in existence have done good work for the very large authorities, but it does not follow that all authorities should follow suit and upset their efficiently functioning all-purpose departments.

Closed Circuit TV in New RAeS Lecture Hall

The Royal Aeronautical Society now have their own lecture hall. It was formally opened by Lord Brabazon of Tara on Friday, 2 December.

Ever since their foundation in 1866, the Society's lectures have had to be given in the halls of other institutions or in the Society's library. Increasing activities made this arrangement more and more unworkable and when, in 1957, the proposals were announced for the reconstruction of Hyde Park Corner, making it possible to develop the rear of the Society's premises, plans were immediately put in hand for the new hall. An appeal was launched and members and the aircraft industry generally, quickly subscribed £90,000.

Work was begun in October, 1959, and completed twelve months later.

Seating 310, the hall is equipped with recording and projecting equipment that is probably unparalleled by any other professional institution in the country. In particular, there is the first British built Xenon slide projector to be installed in a lecture hall; it was made by AEI Sound Equipment Limited. Loud-speakers and a closed circuit television will cover the foyer, council room and the library, so that 800 can be accommodated for a meeting. Equipment is also available so that the television circuit can be fed into national and international circuits. Simultaneous translation into four languages is catered for, each member of the audience having a small personal receiver with headphones.

Around the room is a frieze made up of 28 coats-of-arms representing the Commonwealth country, or city or town in which there are branches of the Society. And on the walls there will be portraits of the Presidents of the Society since 1947. They have been specially commissioned, the cost being borne by the O'Gorman Bequest.

So attractive is the new accommodation that the Society in contrast with their own previous experience, now have advanced bookings from other institutions.

The Coming Opportunity for Skilled Recruitment

Whatever the doubts of so experienced an authority as Lord Citrine as to whether industry holds sole responsibility for training skilled workers, it is not now in doubt that too little is being done to increase the number of Britain's technicians.

Last year 24,000 more boys left school than in 1958. The number of boys going into skilled occupations rose by only 5,500 this is actually a decline in the proportion of available boys taking up skilled employment, and there is little serious evidence to suggest that there is any lack of will among the boys to enter apprenticeships and generally take the necessary first steps.

For the last twenty years the United Kingdom has been persistently short of skilled labour. Mr. John Hare, the Minister of Labour, reminded the recent Industrial Training Council Conference in London of this poor showing when he once again pointed out the coming opportunity of the next two years to rectify the position.

From 570,000 school leavers available for employment last year, the numbers will increase to 720,000 in 1962. With so many economists, either the home or overseas variety, pointing to the static nature of our working population, its comparatively high recruitment of women and its low unemployment pool, the increased numbers of recruits made available by the post-war rise in the birth rate is industry's biggest single recruiting opportunity since the war.

Jumping to It

There is some confidence at the Ministry of Labour that the larger numbers will be absorbed without much difficulty, though problems are anticiparted in Scotland, parts of Wales and in Northern England. So the employer who depends for his expansion upon greater numbers of skilled men must be up and about. It may be that he should have his plans well laid if the larger numbers of young men, or the best of them, are not to pass him by.

The role of the larger firms in industrial training is well known. But there are small and medium size establishments who can show a good record in teaching advanced skills. And what some can do the rest can follow. It is important to see that the legendary German who said " We envy you your bulge " is not able one day to say that, when the time came, we threw the opportunity away.

Pre-Cast Framing Cuts Year off Contract

Building for the extensions to the Commonwealth's largest plate glass factory has been completed twelve months ahead of schedule. Prefabrication and good choice of materials for the roofs and cladding made this possible.

COORDINATION of the design and construction programmes has resulted in a twelve-month saving in building time on an £800,000 extension for a glass factory. Work is nearing completion on the extension which has been built by Holland & Hannen and Cubitts (North West) Limited at Kirk Sandall, near Doncaster, for Pilkington Brothers Limited.

The new work consists of four buildings—a grinding and polishing shop, sand grader building, rouge plant building and storage building—and will form part of the largest plate glass works in the Commonwealth.

Close cooperation from the inception of the project between the central engineering department of Pilkingtons, Cubitts, the consulting engineers, A. J. and J. D. Harris of Victoria Street, London, SW1, and the architect, Gerald R. Smith, A.R.I.B.A., of Larne, Northern Ireland, has played a major part in the success of the undertaking.

Work started on the site in May 1959, and since then regular meetings between the four parties have been arranged to programme the work.

The contract was also speeded up because the superstructures of the buildings were assembled from nearly 2,000 prefabricated concrete units—columns, beams and floor units—weighing over 6,000 tons which were transported 220 miles by road from the manufacturers, Concrete Development Company Limited of Iver, Buckinghamshire. After delivery on the site, the units were craned into position and erected very rapidly. Some of the columns weighed 17½ tons each and the tallest is 70 ft high.

A particular problem was the construction of a machinery deck, over 700 ft long, to carry heavy loading at 18½ ft above ground level. It had to be entirely independent of the main structure yet have high rigidity. These conditions were obtained by providing a separate reinforced *in situ* concrete frame structure resting on independent piles with an *in situ* concrete suspended slab floor. The outer sides of this floor were connected to the main structure by pre-cast concrete floor beams resting on the edge of the floor and supported by a pre-cast concrete edge beam running the length of the shop carried by the main columns.

Grinding and Polishing Shop

The largest of the four buildings is the grinding and polishing shop. It is 950 ft long, has a 60 ft clear span and is 55 ft high. This building, in common with the other three, is carried on 17 in diameter driven piles by Frankipile Limited.

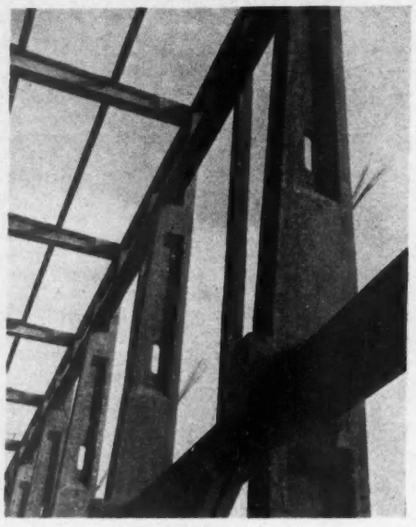
At each end of the machine foundation is a reinforced concrete framework support of unusual complexity supporting the main driving mechanism of the machine.

The main frames are at 25 ft spacing with a double column and expansion joint half-way in the length. The 40 pretensioned prestressed concrete roof beams are each 68 ft long and weigh 8½ tons, and the 80 reinforced concrete columns are each 58 ft long and weigh 17½ tons. The purlins and eaves beams are also of pretensioned prestressed concrete, while the mullions and edge beams are of reinforced concrete.

Deck units, spanning from the machinery bed to the edge beams, are in pretensioned prestressed concrete, using strand tendons, and are designed to take standard Ministry of Transport bridge loading.

The choice of structural and cladding materials has been influenced by the conditions of high humidity in the building. The metal-decked roof is finished with 1½ in insulation board, ¾ in fibreglass and a single layer of mineralised felt, while the underside of the roofing is coloured Galbestos. Sheeting is fixed to the concrete purlins by masonry nails driven into a continuous lightweight concrete fillet. A felt strip laid between the roofing and the concrete avoids any chafing between the concrete purlins and the roof decking. Gutters are formed as part of the roof and the pitch fibre downpipes have been housed internally.

The cladding consists of metal panelling with grey coloured Galbestos exterior and aluminium patent glazing. The patent glazing and cladding are fixed to aluminium cladding rails, which are attached to the main and intermediate columns by aluminium cleats. Weep holes are provided to release condensation which may occur on the inside of the glass. Except for a lower panel of clear glass, ¼ in Georgian wired cast glass has been used on the east elevation and anti-sun glass on the west elevation. The interior of the building is finished with a dado of coloured Galbestos sheeting 4 ft high, behind which is housed electrical wiring.



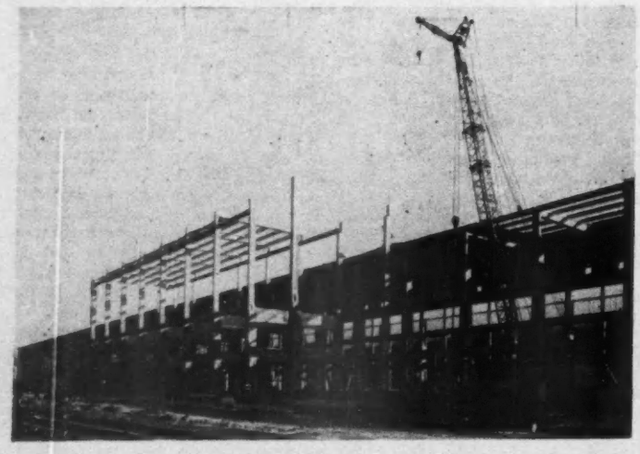
Structural assembly details.

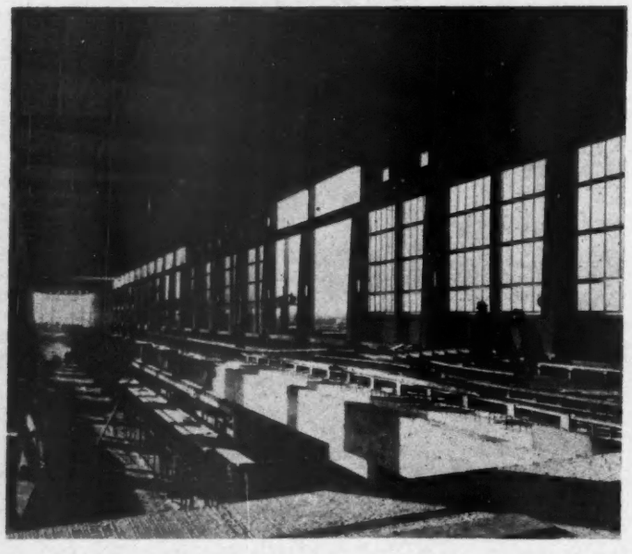
Sand Grader Building

The sand grader building is 275 ft long, 40 ft wide and 65 ft high. At 18 ft above ground level, the building is partly floored for central equipment and offices.

The main floor, 30 ft above ground level, is an *in situ* prestressed concrete slab continuous over eleven spans of 25 ft. Designed for a superimposed load of 450 lb per sq. ft, the slab is 18 in thick over the main beams, reducing to 10 in thick at midspan. Sufficient mild steel reinforcement was provided to enable the shuttering to the structure to be struck prior to prestressing, for which 12/276 Freyssinet cables were used in pairs at 3 ft centres and 275 ft long. Stressing was carried out after completion of concreting. The positions of cables in the floor are marked so that their location will be known if a hole is subsequently required in the floor.

The roof beams, 40 ft long, are of pretensioned prestressed concrete and the moulds were made by cutting down those used for the main building





(*Above*) *Part of the grinding and polishing shop and* (*foreground*) *the sand grader building with cladding of the halls in progress.*

(*Right*) *Interior of the main 950 ft long grinding shop, showing the reinforced concrete machinery deck under construction.*

roof beams. Purlins and eaves beams are of the same type as used in the main building and the mullions are also similar.

The roof of the sand grader building is of coloured Galbestos decking finished with insulation board and mineralised felt. Gutters and down pipes are treated in the same way as those in the main building. Cladding consists of patent glazing and metal panels. The windows to the amenity suite, housing the offices, are aluminium framed and fixed to aluminium cladding rails. By projecting the windows 2 ft, it has been possible to instal convector heaters and cupboards in the recesses. Vitrolite, plaster and plaster paint finishes are used on the brickwork divisions of the suite.

Ceilings are of the suspended type, using Fibreglass acoustic panels and Asbestolux. The conference room ceiling is boarded in Parana pine, fixed on acoustic board and battens.

Rouge Plant Building

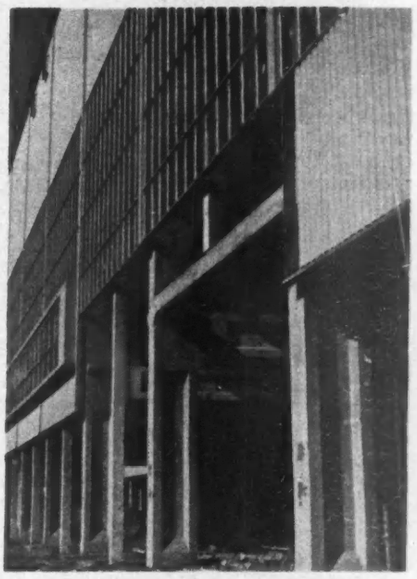
The smallest of the four buildings is the three-storey rouge plant, 50 ft long, 40 ft wide and 50 ft high. It is constructed of simple precast prestressed and reinforced concrete units. All the cladding is carried on prestressed concrete channel-shaped sheeting rails. The floors were designed for loads up to 350 lb per sq. ft and built partly in prestressed units by Havitgoods of Doncaster and partly *in situ*.

Coloured Galbestos panels and aluminium patent glazing, has been used for the cladding, as for the main building, but fixings are to treated timber battens attached to concrete rails. Glazing is clear glss to the first and second floors and Georgian wired cast to the ground floor. The roof, gutters and down pipes are of similar construction to those of the main building. Floor finishes are generally granolithic throughout and the internal walls are of brick, flush pointed and left undecorated. A brick dado wall, 4 ft 6 in high, is provided to external walls.

Storage Building

All structural units of the storage building (950 ft long, 50 ft wide and 30 ft high) have been cast in concrete made with white cement to give a lighter and cleaner appearance. The units were coated with a silicone solution before leaving CDC's works so that marks made during erection could be washed off. Generally the form of construction is similar to that adopted in the other three buildings.

Throughout the four buildings the choice of materials has been made to minimise painting and general maintenance. There is virtually no painting in the main building. Electrically and hand-operated roller shutters and access doors are provided in all buildings and these are painted. Aluminium has been used extensively for sheeting and cladding rails to avoid rusting.



Details of sheeting and glazing.

Plastic Films Seal Storage Ponds

Another use has recently been found for vinyl and polyethylene film: they have been successfully incorporated into earth embankments of reservoirs. Their function is to act as an impermeable lining, taking the place of the conventional concrete or clay lining usually used in water-retaining structures. Experience to date appears to be limited to storage ponds of a size that might be installed on a farm or in a works, up to 2 million gallons capacity.

Experimental research into the use of plastic film linings for water-retaining structures was commenced in 1954 by the Utah Agricultural Experimental Research Station. Exhaustive tests were carried out with several different types of plastic film. The factors investigated were biological deterioration of the film, its ability as a lining to withstand weathering and to resist plant root and sprout penetration, possible rupture of the film under a hydrostatic head, and seepage from the completed reservoir lined with a vinyl film.

Results from these studies were encouraging enough for plastic linings to be incorporated in full-scale dam construction projects.

A number of reservoirs of varying size have so far been built using both vinyl and polyethylene linings. The experience gained, particularly with black vinyl film, has led the designers of the structures to expect a life of 25 years from the plastic lining.

Three reservoirs have recently been completed north of Salt Lake City, Utah. They have capacities of 1, 5 and 9 acre-feet (1 acre-foot = 43,560 cu. ft) and have been constructed in sandy gravel containing a small amount of clay, a soil which in itself was not impervious to water.

The vinyl lining was available in widths up to 61 ft, in steps of 52 in. Fabrication of the individual pieces was carried out by the Union Carbide Plastics Company using a solvent lap seaming process.

The 9 acre-ft reservoir was lined with four sheets of 8 mm polyethylene chloride film. Three of these sheets measured 56 ft by 296 ft, while the fourth measured 30 ft by 296 ft. For the 5 acre-ft reservoir four pieces of sheeting with dimensions of 48 ft by 186 ft were used. Only two pieces of plastic were used to line the smallest reservoir, they each measured 61 ft by 105 ft. To place the plastic sheeting into position four men were necessary. It arrived at the site folded like a concertina and it was first unfolded longitudinally, followed by transverse unfolding, the men wearing gloves so that the film was not accidentally punctured. After opening out, the film was stretched to remove any wrinkles and then placed on the ground without tension. Around the top of the reservoir the lining was secured by burying it in a trench. Sealing around valves and pipes where the plastic had been cut was ensured by employing a mastic sealing compound.

Field welding of the separate pieces of plastic was carried out by lapping the sheets over one another by 6 in and then using an adhesive solvent. To protect the lining, a 6 in thick layer of fine sandy material was carefully placed over the plastic followed by a further 6 in layer of small stones on the embankment as a protection against erosion.

On completion of the embankments, the reservoirs were tested for water-tightness but only normal evaporation losses were observed. Experience so far has confirmed that the anticipated 25 years of life of the lining will be reached without difficulty.

Current Motorway Experience

The £6 million Ross Motorway, recently opened by Mr. Ernest Marples, Minister of Transport, provides a fast direct route between the industrial Midlands and South Wales.

Speaking at the opening, Mr. Marples said that the new motorway was a first class high speed road—efficient, safe and beautiful. It was deliberately designed as a dual two lane carriageway because the scientific estimate of traffic likely to use it did not warrant a dual three lane carriageway. It would have been a foolish waste of resources and agricultural land to build three lanes where two lanes sufficed.

Practical experience on M1 showed that harder and wider shoulders were needed on our newer motorways. The shoulders on Ross Motorway —8 ft wide in 11 ft 6 in verges—were strong enough in construction but narrower than the latest standards. However, the motorway was shorter than M1 and would carry less traffic, so in practice the narrow shoulders should not be a serious defect.

The driver on the Ross Motorway, the Minister continued, would also enjoy beauty. The motorway opened up fine views and did nothing itself to mar them. The road and the bridges harmonised with the landscape. The cuttings and embankments would be grassed or planted to hide the scars of construction, but no planting would be done that would hide the view.

Route M50, as the new motorway will be shown on future maps, starts near Tewkesbury and passes through undulating country to the outskirts of Ross-on-Wye, a distance of 21 miles. At the eastern end, it will be linked with the northern section of the Birmingham-Bristol motorway, now under construction, but pending completion of this northern section there is a temporary connection with the A38 at Brockeridge Common.

At the western end, the Ross Motorway connects with the newly-opened Ross By-pass, which, though not restricted to motor vehicles, is an essential part of the motorway scheme. The by-pass is carried over the River Wye and the Wye flood plain by the Bridstow Bridge and with its associated embankments.

From the western end of the Ross By-pass at Wilton in Herefordshire, the existing main roads —all of which are to be reconstructed—lead on to Swansea via the Heads of the Valleys Road and thence to Newport and Cardiff.

The motorway consists of duel 24 ft carriageways having a top surface of hot rolled asphalt and has involved the construction of 39 bridges. All the bridges have been designed to carry abnormal invisible loads upwards of 150 tons and each carriageway is able to take 35,000 passenger car units a day. Maximum gradients are limited to 1 in 25 and curvature to a radius of 2,046 ft, giving a designed speed for the road of 70 m.p.h.

The main contractors have been A. E. Farr Limited, London, SW1; R. M. Douglas (Contractors) Limited, Birmingham; and Tarmac Civil Engineering, London, W1.

Natural Resources Catalyse Each Other

Scotland can develop her potential by recognising the changing value of interlinked resources. The first step has been to hold a symposium.

By H. Munro Wilson
Technical Secretary, The Scottish Council

SCOTLAND is a country typical of the older tradition. It is a country which developed, like the United Kingdom as a whole, through the industrial revolution, on a basis of prominent single assets such as coal, iron-bearing minerals, and a previous experience of merchant banking and trade. Her most valuable resource is now human intelligence and skill. That resource she has been exporting at a greater rate than any other country.

Country	*Net migration loss per cent of population*
Scotland	8·0
England and Wales	0·5
Italy	2·6
Norway	2·9
Sweden	1·5
Denmark	1·2

At the same time, investigations by teams of scientists working together as never before—a phenomenon of the Second World War—has produced a surge of new technical ideas and new material sources, which has led to more sophisticated rethinking about our biological and mineral resources, soil and water.

In Scotland, for these two reasons, there has been a feeling that it is time to take stock—to look to alternative investments. Therefore, a fact-finding meeting was held as a symposium in the first few days of November, which was attended by eminent people from many walks of life and countries overseas. The programme was as follows.

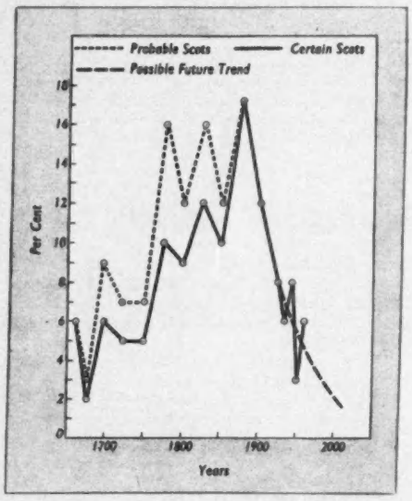
1st Day	*2nd Day*	*3rd Day*
Basic resource facts	*Utilisation of resources*	*Mechanics of resource development*
Soil	Multiple land use	Human resources
Water	Water	The mechanics
Minerals	Fuel and energy	The administration
Fish and wildlife	Minerals	
	Biological resources	
	Recreation	
	Wildlife	

The meeting showed that many important and common resources, such as water and minerals, require to be measured more thoroughly at all stages of their occurrence: in the case of water, the measurement—against an appropriate time-scale—of precipitation, flow, use and discharge; in the case of minerals, through geochemical surveys of soils and rocks, and follow-up by complementary survey methods.

Also, in examining the application of human resources, undesirable trends were apparent, as are shown in the graph. The curve does not necessarily show a change in native intelligence, but may rather indicate change in application relative to people in other parts of the United Kingdom.

On the integrated use of resources there was some considerable discussion of a constructive kind. There were covered: the pressures imposed by urban sprawl on good agricultural land; preservation of recreational facilities and quiet places in the face of other worthy objectives, including tourism; forest trees for the production of timber and forest trees for soil improvement; land for animals, cash crops, deer and game; the maintenance of fresh-water and marine life; the provision of water for irrigation where assessments showed that the need exceeded water availability, even in Scotland; and finally an extremely good climate, but bad weather.

Scotland (and the United Kingdom) is a country where the selling of ideas through the production of small-quantity specialised goods pays off better than over-many large-scale mass production plants after the American pattern; where leadership springs from the independence of a large number of smaller firms, farms and profitable operations of many kinds; where leaders would, to our detriment, be lost if centralised efficiency were to go too far. Similarly, it is part of our life to maintain hedgerows, small woodlands and copses rather than to remove every shade to give more efficient cash crop farming; it is part of our life to maintain a balance of partridge and other wildlife in our lowland areas, and grouse on our high moors. If we drain our high moors, we lose our wildlife, we produce flash floods, we alter—there and elsewhere—the biological balance, without which the land will be made progressively less valuable, and finally give way to bad land and bare rock; a process which in some areas has already proceeded far, as a result of the removal over the centuries of the original forest cover which controlled water movement, improved the soil, and encouraged the grasses.



Trends in the application of human resources: Scottish Fellows of the Royal Society as a percentage of British Fellows.

Efficiency of functional development can lead to inefficiency overall, and in particular to a further rundown of our renewable resources, on which we will depend more and more as the fund resources, such as minerals, become more difficult or expensive to obtain.

The need for clean rivers and clean air is already being tackled. There are many other problems to be recognised and adverse trends to be countered in order to preserve the best of the natural processes, one facet of which is the multicultural use of land and the maintenance of a biotic balance.

In Britain and Scotland, where four-fifths of our raw materials and half our food are imported, and the products of our brains are exported, a strategy for resources must be mainly directed at human resources, land utilisation, water, and climate. Particular emphasis must be paid to wild life, forest and agriculture. That is, all the renewable resources. In Scotland, moreover, very strong views are expressed concerning the desirability of surveying mineral resources using the latest techniques, even though Scotland is perhaps the most comprehensively surveyed country in the world—from the geological point of view. Static or fund resources, such as minerals, can be put to work by a change of attitude towards them. Through an attitude "here is a material—what can it be made to do?" rather than the prevailing attitude "here is a function, what materials will suit?"

As a result of the latter attitude over the years certain materials have become "standard" although there may well be many alternatives. That there are alternatives is being demonstrated by the new industrial materials based on hydrocarbons which are coming from organic sources, and by new applications of ceramics.

All this boils down to certain requirements.
(1) The need to define regions in which clear combinations of resources predominate; to establish the determinable economic factors; to assess the imponderables; and to establish the limits: so that over a long-term period developments can be encouraged which take activities forward concurrently, and generally in a complementary manner, rather than in a conflicting way—although at certain points in time, conflicts are bound to occur.
(2) (*a*) The general acceptance of a need by vocationally educated people, to aspire to a full understanding of integrated resource development, its problems and possibilities; and
(*b*) the need for strengthening "the sources of an intellectual irrigation system which spreads clear thinking and respect for culture throughout our society."

Throughout the papers and discussions, known basic resources such as fish, agricultural products and game were shown to have valuable possibilities, given more vigorous marketing and distribution. The recognition of a need for a working link between research and development, and selling, was a major (if somewhat unholy) association called for.

There are many organisations which can bring weight to bear on resource development, and the balancing of these weights is part of our democratic system... These organisations are the following.
(1) Private industry, including agriculture, which sets out to obtain an excess of revenue over costs.
(2) Nationalised industry, which should cover its costs.
(3) Public corporations, where revenue may not be associated with costs.
(4) The State, which gives constitutional expression to the wishes of society.
(5) Local authorities, which apply state legislation and may also own resources.
(6) Voluntary associations. These in aggregate, are considerable and may bring important influences to bear. They are a vital part of our system of controls.

Resource assessment and inter-resource values are moving things. Not only do they depend on the fits and starts of progress in technical know-how; they depend on economic climate, the extremes of which are war and peace, and they depend on the state of our fiscal and trading systems.

The symposium gave those people who are already knowledgeable in these fields a vantage point from which to see further, over a complex of different branches of applied learning and practice; to see where interdependence of one resource upon another matters; to see where increasing functional efficiency leads to decreasing efficiency overall. "... The best specialist is not the man who knows his own subject and nothing else, but the man who knows his own subject supremely well and the more "besides" the better, because all knowledge bears upon, illumines, and fortifies all other knowledge."

Work is in hand to implement the findings of the symposium, the transactions of which will be published. The direction of this work must be by people whose thoughts cross the boundaries between traditional educational patterns and scientific disciplines, and who are aware of the resource changes and pressures in all countries, and whose thinking is geared to meet with poise the hard competition for markets.

Design for Safety Should a Crash Occur

Once a car has been designed to minimise the risk of accident, further precautions should be taken to protect driver and passengers from injury in the event of a crash.

By John Rabson, A.M.I.Mech.E., M.S.A.E.

WHAT can be done to increase the safety of driver and passengers, should they be unfortunate enough to be involved in an accident? The answer is that there are a number of detail modifications that can be made, or additional accessories that can be bought. The design of vehicles to minimise the risk of crashes taking place at all was treated last week.

The most talked-about fitting of recent months has been the seat belt, and at least three general types are available: the simple lap strap, very much on the lines of the equipment in passenger-carrying aircraft; the full harness with both belt and shoulder straps; and falling midway between these two, the diagonal belt. All these devices are designed to ensure that in the event of a collision the deceleration of the driver and passengers is comparable to that of the car—in other words, to prevent them from shooting forward and passing out through the windscreen.

The efficiency of such equipment depends on two things: the amount that the restraining force is distributed over the anotomy, and the way the belts are attached to the vehicle body structure. It is absolutely essential that owners wishing to fit seat belts to their vehicles should be able to obtain accurate information as to the parts of the structure which have sufficient strength to carry the loads imposed on the belt anchorage points in the event of a crash. Obviously it is quite useless to fit equipment of this kind to weak anchorage points which would readily become detached under the influence of the load applied. No doubt vehicle manufacturers would be able to supply this information, and its publication in the form of a bulletin would be very desirable. It might also influence the choice of a particular seat belt for a particular car.

All other things being equal, the actual choice of seat belt will depend on the amount of control or restraint that is desired, but probably the full harness is the most effective, and the simple lap strap the least. This difference becomes apparent if one considers vehicles where the facia and windscreen are relatively close to the driver and front passenger, because the restraint from a lap strap will not prevent the top half of the body from travelling forward towards the windscreen if the vehicle is decelerated violently.

HEADS!

Although hardwood has been popular for interior fittings, and is still regarded as a hallmark of quality in car interiors, as its name implies it does not have the quality of resilience which might be desirable for a component located immediately in front of driver and passenger. Further, the problem is not eased by the variety of hardware frequently to be found in the form of knobs and projections on the interior of a motor car. This fault has been realised by some manufacturers, and there is a slow movement towards the replacement of hardwood by more resilient materials, such as leather covered foam rubbers.

It is probable that manufacturers have hesitated to proceed as quickly as some of them may have wished owing to the dictates of fashion, probably backed up by sales-department figures which indicate that hardwood veneer (even if it is backed by metal in certain cases) helps to give a car the quality label attractive to customers. Fortunately there are signs that this era is passing, and famous Italian car designers have created flowing facias which sweep over a raised instrument panel (correctly located symmetrically above the steering column), the whole covered in dark leather to eliminate reflections in sloping windscreens.

While it is appreciated that all design is a matter of compromise, in the interests of safety the bench-type seat should perhaps be scrutinised. Apart from the fact that it permits a third person to travel with his head in a position where it could make violent contact with the driving mirror, a component which is seldom shielded or made of unbreakable glass, a one-piece seat does not cater for the needs of a tall driver and a shorter passenger. The problem is further aggravated by the fact that because of pedal projection from the toe board, the relative cushion position must always result in the seat being placed further back than is desirable for maximum passenger comfort, even if driver and passenger have the same leg length. Thus with a bench type seat the front passenger is seldom able to enjoy the stabilising advantages of a correctly placed toe board.

ALL-ROUND VISIBILITY

Still considering the layout of the cockpit, the steering wheel should not be forgotten. On some models it is attached to a long forward-facing column extending almost to the front of the vehicle, and might be likened to a dipped jousting lance, familiar in medieval tournament, and more effective in wounding the driver rather than his opponent in the event of an accident. This danger can be very much reduced, first in the basic layout of the steering by arranging that the actual steering box is placed further to the rear, in a less vulnerable position; by including joints in the steering column; and by designing the system to telescope under impact.

Even with seat belts and a padded interior, the motorist cannot proceed safely unless he can see where he is going—therefore a safe vehicle must have good all-round visibility. It must be achieved without loss of structural efficiency, to prevent the roof from collapsing if the vehicle is overturned. Even with a combination of strong but slender pillars and an adequate glass area, this problem is still not fully resolved, because a large glass area is effective only if the driver can see through it. Therefore, the vehicle must have efficient wipers to remove rain and mud from the windscreen, the glass must be heated to prevent the formation of ice in cold weather—this latter point also applies to the rear window, and there must be means of preventing the inside of the glass from misting up because of differences in atmospheric conditions on each side of the glass.

Although present-day fresh-air heating equipment is effective as regards de-icing and clearing the windscreen, only the most expensive cars have equipment to clear the rear window as a standard fitting, and hardly any make provision for demisting the side windows. On far too many vehicles the only effective way of obtaining maximum sideways vision in bad weather is to open a window, and if this is done it must of course affect the efficiency of the equipment for de-icing the screen.

Developments to windscreen-wiper motors and wiper blades now make it possible to cover a very large percentage of the modern curved windscreen, and provided that they have only water to deal with, they can be relied upon to clear the screen effectively, yet they are less effective at a time when they are needed most—but here the fault is not in the equipment but rather with the "other vehicle."

If one considers the problem of driving on a wet road under moderate traffic conditions, the following train of events is likely to occur. With a relatively clear road ahead, the driver may be travelling at a normal cruising speed, and although it is raining, his wipers are able to cope with the water, and he has good forward visibility. Yet as he approaches a slow-moving vehicle, and requires if anything an extra-clean screen in order to see that it is safe to pass, frequently he will find that the tyres of the vehicle in front will pump quantities of muddy water into the air, to be thrown back and deposited on his screen. This mixture of muddy water will be further concentrated if there are other vehicles moving in the opposite direction, and although screen washing equipment will be of some assistance, the general level of visibility will be reduced rather than increased.

ELIMINATING MUD SPRAY

Surely it is not beyond the ingenuity of either the vehicle designer or the accessory manufacturer to overcome this problem? Some vehicles are much worse than others in this respect: mud flaps fitted to certain continental vehicles are of some assistance, but commercial vehicles are in many cases the worst offenders, and often their mudguards are reduced to a minimum. There is little doubt that greater attention to detail design, with this problem in mind, could very considerably reduce, if not completely eliminate, the hazard.

Three types of seat belt are available: full harness, diagonal belt, and simple lap strap. Equipment by Irving Air Chute Limited, approved by the British Standards Institution.

Expert in the Witness Box

Courts are not hostile to the expert witness but they need to be persuaded that they should prefer his view to their own and other opinions.

By F. H. B. Layfield

EVERYONE is familiar with the great trial, sweeping all other news from the headlines. Great is the interest in the story as it unfolds, great the interest in witnesses as they come and go; greatest of all the interest when the expert speaks. Then, we instinctively realise that the whole outcome may turn upon question and answer given in less than the span of an hour, when men like Bernard Spilsbury and William Wilcox face a Marshall Hall or a Norman Birkett.

Few of us, either as counsel or as expert, are likely to fill such eminent roles as these. Yet a great many engineers, soon or late, take their place in the witness box in an expert capacity. A moment's reflection on the varying fortunes of experts in famous trials will prompt most engineers to ask how they will essay the difficult task of an expert witness when it falls to their lot. Some, who have already had that experience, may wonder, even more than the novice, if there is not more to the job than the exercise of his own professional expertise? Perhaps the best way to answer the question is to consider the expert witness as he is seen by the Court.

FACTS AND OPINIONS

Whether the proceedings are heard by a Judge, a commissioner, an inspector or an arbitrator, he is there to hear and determine a dispute. He, who for convenience we will call the Judge, must finally give judgment on the issue before him. To this end, an array of witnesses will be produced before him, each of whom will attempt to add to the Judge's knowledge of the facts concerning the dispute. These witnesses, generally speaking, will be confined to testifying as to *facts*, they will not normally be allowed to give opinions. They will not be allowed to look at notes, books or documents except in certain special instances.

When the expert is called, different considerations apply to some extent. Here is a witness whose main function is to help the Court with his *opinion*. That opinion may be as to what further facts can be inferred from admitted facts, or how to interpret the meaning of those established facts, or both. The expert is, accordingly, granted privileges denied to the ordinary witness; he may produce and refer to a prepared written statement or "proof" and he may refer to textbooks, reference works and similar documents. Thus, it is not his memory upon which the Court will rely, but upon his other mental powers.

The expert is there to help the Court, but *only* to help the Court. The Judge knows that in the last analysis, the judgment is his; he will listen with interest, respect and—sometimes—a little jealousy to what the expert says. Throughout the expert's evidence, the Judge will be asking himself what manner of man the expert is.

QUALIFICATIONS AND EXPERIENCE

Perhaps the first matter upon which the Judge will wish to be satisfied is the qualification and experience of the witness whose views he is being asked to adopt. The academic distinction of the witness may, of course, be important but most Judges are more impressed, as a rule, by practical experience. These qualifications, and their relevance to the matter in issue, should be established clearly at the outset.

The expert will next need to turn to a rehearsal of the facts upon which his opinion will be based. This part of his evidence is likely to be listened to with, perhaps, unexpected interest. The Judge may well feel, during a complicated case, that he will have only a limited chance to test the validity of the witnesses' opinions. On the other hand, Judges of all kinds are particularly skilled in the assessment, arrangement and presentation of facts. They are, therefore, able to form a clear picture of the expert's accuracy of mind, sense of relevance and power of analysis, if they examine carefully how he presents his factual basis and what it contains.

Here the expert may be wise to remember that, apart from facts observed, recorded and, perhaps, measured by himself (as, for example, the condition of a structural member after an accident), many facts may be in dispute. Sometimes, it will be useful for him to state, or at least be ready to state, the sources of all facts not within his own direct knowledge. By the same token, any assumptions he makes should manifestly be distinguished from facts, and both of them from his opinions and conclusions. It will, rightly, be said that an engineer, by training, invariably makes these distinctions, but it cannot be too strongly emphasised that he should make that manifest.

When the expert, having examined the facts, comes to give the all-important opinions he has formed, based upon those facts, he will do well to bear one golden rule in mind. Like the advocate, he should remember that the Court has to be *persuaded*. A Judge will not lightly abandon his function, and right, to come to his own conclusions. If he is to accept the argument put forward he must be persuaded of its rightness. The clarity, logic and completeness of the argument must convince him.

If the Judge is to be impressed by the clarity of the expert's argument, it follows that the expert must speak in language which is as plain in its terms as it is clear in enunciation. Many an expert of prodigous ability has failed to convince a Court of the correctness of his opinion because his opinion has been couched in a form which was as abstruse as it was over-technical.

EXPLAINING TECHNICAL TERMS

If technical expressions not universally understood can be avoided they should be; if they cannot be avoided, as often they cannot, they should be clearly and graphically explained.

Possibly the most frequent error expert engineer witnesses make is to assume that, where an arbitrator is concerned, the arbitrator, being a technician himself, understands fully all the technical terms employed by the witness. Apart from the fact that bitter experience soon shows that this is an incorrect assumption, it is wise to remember that the matter may be the subject of an appeal to the Courts. If the latter course occurs, the detailed evidence given at the first hearing may be carefully scrutinised and, to say the least, it may well be desirable that the Court should be able clearly to understand what the expert meant. A Court does not regard obscurity as a proof of technical ability.

A tribunal, of whatever kind, will examine the expert's conclusions with minute care. It usually happens that the Judge will, between the actual hearing of the case and giving his decision or judgment, have time in which to look carefully at the evidence. Then there is an opportunity for the Judge to consider upon what the expert's opinion appears to be based and the validity of the attacks that have been made upon it. No doubt the best basis for those conclusions is the expert's long experience of similar circumstances, but sometimes the conclusion will depend upon accredited theories and hypotheses. In the latter case, the sources should be indicated and something may need to be said about any conflicting theories, and why these conflicting theories have been rejected.

All that has been said so far concerns those parts of the hearing in which the expert has not been directly under fire. His real test, in everyone's eyes, begins with his cross-examination. For the first time he may be treated as hostile and his evidence fully probed. His demeanour will be carefully watched. Every expert, though called by one side or another, is, after all, expected to bring an independent mind to bear on the matter. So he will be watched when under pressure especially to see if he becomes partisan.

TIME TO THINK

Several fresh points arise at this stage. The witness could usefully remind himself again that he is a witness of opinion and is not there for his memory of the facts. When examined by his own side he is unlikely to be led into giving hurried answers. Under pressure from the other side there is often the temptation to give a snap answer; he will be more appreciated if he takes all the time he reasonably needs, reminding himself of the relevant facts, if necessary, before answering. Nevertheless, whether his answer be slow or quick, the worst impression that an expert can give is that he is evading a question. This may arise because of an elementary failure to listen carefully to the questions, usually carefully worded, and, in due course, to answer them. Alternatively, the witness may really be avoiding the question. Whichever it be, if the Judge thinks he detects either tendency he is not likely to be very impressed with the integrity, care, or intelligence of the man whose views he is presently being asked to adopt.

Next only in danger to the hazards of evasion comes another snare. Time and again propositions are put to expert witnesses, the truth of which is plain, and yet they refuse to accept them. The effect of a failure to admit or accept propositions which are evidently right can be very damaging. The Judge is made thereby to doubt not only the witness's ability to exercise judgment but also to question his impartiality. Few things impress a Court more favourably than frank and generous admission by a witness of points that are plainly right. If the witness desires to qualify his answer he will always have the opportunity.

Finally, the Judge will ask himself if the expert before him recognises his limitations. There will always be those in Court who are ready to lure an incautious witness into expressions of opinion that lie beyond his expertise. If the witness falls into this trap he does himself irreparable harm, for the Court may reasonably conclude that he seems ready to express opinions regardless of whether such opinions are soundly based on experience and knowledge.

SUMMARY

Only the most eminent of experts can safely neglect to demonstrate their fitness to give their evidence and, indeed, they rarely fail to do so. A Judge will want to detect in the witness a mastery of fact and thoroughness in analysis, will want to hear the witness's conclusion expressed in clear English and graphically if possible. That conclusion should be compelling in its logic and clearly preferable to any available alternatives. The witness should impress the Judge as careful and cautious but not, of course, to the point of seeming an old woman. While an expert is well advised always, if asked, to accept any true proposition, he should be on guard against venturing on to ground not peculiarly his own. Above all, he could do worse than bear in mind throughout that if the Court is to be led to adopt his view it will only do so because his opinions convince. If he does even a majority of these things he may be sure the Court will listen attentively. But if he ignores most of these elementary rules, though he may be ever so eminent in his own branch of knowledge, he runs the risk that the Court will fail to be impressed when the expert speaks.

Pressure Vessel Limits

ADVANCES in the metallurgical limits to which reactor pressure vessels may safely be exposed have been of great assistance to the reactor designer. The increase in both the maximum reactor temperature and pressure have improved the rate of heat transfer and overall efficiency. A symposium held in London by the Iron and Steel Institute on "Steels for Reactor Pressure Circuits" from 30 November to 2 December has helped to review the art at its present position. The use of thicker plate has brought many fabrication and economic problems, and the catastrophe that would result from a broken pressure vessel has led to a very thorough examination of the metallurgical properties, which until recently have been spartanly examined even in the case of the more common metals. The necessity to keep the weight and thickness to an absolute minimum makes a critical examination all the more vital. Tables I and II give some basic parameters.

Radiation Hardening of Steel

When a metal is irradiated with fast neutrons

Fig. 1 Electron microscope transmission photograph of copper (× 132,000) after irradiation to a dose of 1·4 × 10²⁰ neutrons per sq. cm, showing loops formed by clustered defects.

it becomes harder. The neutrons knock atoms out of place in the crystal lattice and these displaced atoms (called interstitials) and the vacant lattice sites, which they leave behind, act rather like alloy atoms in hardening the metal. These point defects can diffuse inside the metal under thermal agitation, and in so doing produce various ageing and annealing effects. Although the displaced atoms and vacant lattices can annihilate each other when they meet, the process resembles the ageing of solid solutions, and radiation hardening is often strongest when the point defects are clumped together like fine precipitates. These clumps, as seen under an electron microscope, are shown in Fig. 1. Initially the rate of hardening is rapid, but slows down after large doses of radiation.

Radiation Embrittlement of Steel

The dominating feature of the brittleness of structural steel is the notch-sensitive ductile-brittle transition. On cooling below a certain range of temperature, the fracture is no longer tough and fibrous, but brittle and crystalline following cleavage lines through the grains. The only detectable difference between the ductile and brittle states is that the yield stress is higher in the brittle state. All the evidence points to the conclusion that the brittleness occurs whenever the yield stress is raised above a certain range, usually about 150,000 lb per sq. in. Reduction of temperature is one means of bringing about the transition to brittle fracture. The brittle point may be raised to room temperature and above by several methods, for example radiation hardening or the stress relieving of the assembled pressure vessels. Although the latter minimises the risk of cracking due to constructional stresses, it has the effect of raising the transition temperature. Except for the most extreme forms of brittleness, it seems that the brittle crack is started by the act of plastic deformation, slip or twinning. After extensive experiments on steel, it has been shown that the transition temperature rises by nearly 2° C for each 1,000 lb per sq. in increase in tensile yield stress.

Notch Initiation

In general three things are needed to promote a brittle fracture in a large steel structure: a notch, stress, and a temperature below the crack propagation temperature of the material. Such a failure does not normally start as a brittle crack but as a ductile fibrous fracture at the root of the notch; the combination of high rate of strain and plastic constraint, which follows in the zone immediately ahead of the advancing ductile crack, produces the necessary elevation of the yield stress to convert the fracture into a brittle one. The primary function of the notch, which may be caused by a defect in the steel plate or a welding defect, is to produce a localised concentration of plastic strain sufficient to start ductile fracture under the action of the stress in the material. When this stress approaches the static yield strength of the material, caused for example by a faulty designed structure or strains that have not been relieved by annealing, the ductile fracture is likely to start at the root of a sharp notch. ("Theoretical Aspects of Radiation Damage and Brittle Fracture in Steel Pressure Vessels," by A. H. Cotterell.)

Creep Consternation

Creep poses another problem to the reactor pressure vessel designer and this factor has been treated in a paper by J. H. Robertson and R. W. Nichols by collecting information from various sources. For the aluminium grain refined steel, the results indicate that 0·2 per cent creep strain will occur in 200,000 hours at 400° C and a stress of 3½ tons per sq. in. Fig. 2 illustrates the effect

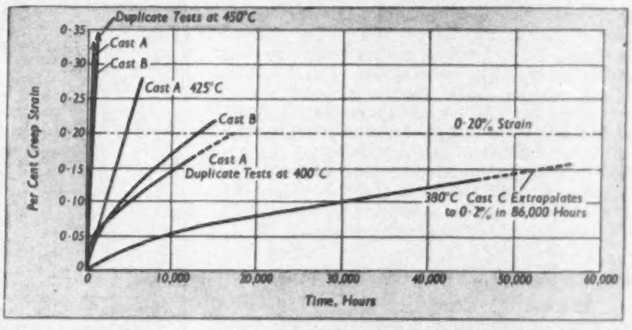


Fig. 2 Results of creep tests on aluminium grain refined steel of slightly differing compositions at varying temperatures.

of temperature on creep for an aluminium grain refined steel. It is interesting to note the rapid increase in the rate of percentage creep strain for a relatively small increase in temperature. The open hearth silicon-killed steel shows a higher creep strength under similar conditions, but an accurate extrapolation is not possible due to inflexions in the experimental stress/strain curves. The higher creep resistance of silicon-killed steel is assumed to be caused by the difference in the free nitrogen content. In addition, some stress rupture tests gave the stress for rupture after 200,000 hours at 400° C as 8·4 tons per sq. in for the aluminium grain refined steel, and 12 tons per sq. in for the silicon-killed steel examined.

Electric Furnace Preparations

Results from specimens prepared by the electric furnace process are not sufficiently extensive to draw definite conclusions, but it appears that stress relieving, and prolonging the time or raising the stress relieving temperature, decrease the creep resistance of silicon-killed steel, but may have less effect on the creep resistance of the aluminium grain refined steel.

To a large extent, the problem of creep is overcome by introducing cooling of the pressure vessel.

Effect of Irradiating Temperature

The Oak Ridge National Laboratory have inspected the different effects that are to be found by varying the temperature of irradiation. Irradiation at temperatures above 300° C usually results in smaller changes in mechanical properties compared with similar radiation doses at temperatures below 100° C. However, between 100° C and 300° C, the results often show a greater change in properties, which has been explained in a paper by R. G. Berggren entitled "Neutron Irradiation Effects in Steels." Post-irradiation recovery studies have shown that several recovery mechanisms are active in both post-irradiation annealing and in elevated temperature irradiation.

Sodium and Corrosion

The conclusions that C. Tyzack drew from his

TABLE I:—*Some Details of United Kingdom Reactor Pressure Vessels*

Reactor site	Number of reactors	Contractors	Working pressure, lb per sq. in gauge	Estimated highest steel temperature, °C	Type of steel	Internal diameter	Plate thickness, in
Calder Hall ..	4	Whessoe	100	340	Aluminium grain refined	Cylindrical vessel with dome ends 37 ft diameter, height 71 ft	2
Chapelcross ..	4	Whessoe	100	340	Aluminium grain refined		
Berkeley	2	TNPG	125	340	Silicon killed	Cylindrical vessel with dome ends 50 ft diameter, height 80 ft	3
Bradwell	2	TNPG	132	370	Silicon killed	66 ft 19 in	3 and 4
Hinkley Point ..	2	APP	185	340	Silicon killed	67 ft	3
Hunterston ..	2	GEC	150	260	Aluminium grain refined ..	70 ft	2⅞ and 3
Trawsfynydd ..	2	APC	240	260	Silicon killed	61 ft	3½
Dungeness.. ..	2	TNPG	268	250	Aluminium grain refined	62 ft 6 in	4 and 4½

TABLE II.—*Typical Compositions of United Kingdom Reactor Pressure Vessel Steels*

Steel	Type	Specification of typical composition (per cent)					Typical aluminium addition per ton of steel
		Carbon	Silicon	Manganese	Sulphur	Phosphorus	
1	Silicon killed pressure vessel mild steel	0·16	0·17	1·3	0·03	0·03	None
2	,, ,, ...	0·2	0·2	1·0	0·03	0·03	4-8 oz
3	,, ,, ...	0·16	0·2	1·3	0·03	0·03	4-8 oz
4	Aluminium grain-refined pressure vessel mild steel ..	0·16	0·13	1·3	0·03	0·03	2 lb

paper on the "Corrosion of Iron and Steel in Liquid Sodium" show that there are basically two types of corrosion. The solution or mass transfer effects, and chemical effects due to reactions between the metal and impurities in the sodium, but the two effects frequently interact upon one another. For example, the rate of mass transfer of iron depends on the oxygen content of the sodium, possibly through the agency of a double oxide, which is stable only over restricted temperature ranges and oxygen levels. It is apparent that at the oxygen levels attainable in properly designed cold trapped circuits no simple oxides of iron, chromium or nickel will be stable. It is also clear that the ferrate $(Na_2O)_2(FeO)$ can exist under conditions when there is free sodium monoxide present, but the precise oxygen level for a given temperature that this compound is unstable with respect to iron and oxygen is still uncertain. The possibility of the carburisation of stainless steels and plain carbon steels due to the presence of carbon impurities in the sodium must also be recognised.

Contribution from Niobium

Niobium is found to hold high promise for applications in the nuclear field. The effect of niobium as a grain-refining element and its ability to raise the yield values of carbon steel relative to the tensile strength are well known. In carbon steels for nuclear applications, niobium is free from the major objection to aluminium as a grain-refining element, namely, the tendency of aluminium-treated steel to graphatise. The impact and tensile properties are also improved, but a wider investigation is necessary. ("Niobium in Carbon and Low-Alloy Steels," by J. E. Russell.)

Lloyd's Requirements

The Land Division of the Lloyd's Register of Shipping has prepared a new list of the provisional requirements. They are framed to give guidance in the information of proposals for the design, manufacture and testing of pressure components intended for land based nuclear plants which are to be built under the Society's survey. Any nuclear plant being constructed under the Society must conform to the approved plans and be built from materials tested by the Society's Surveyors who will witness and supervise all stages of construction and the final pressure testing of the plant. In addition to the factors normally taken into account for non-nuclear services, the following must also be considered: the containment of radioactive materials, the effect of neutron irradiation on materials of construction, and the accessibility for inspection and maintenance. Metallurgical factors must all come up to the required standards. Pressure vessels and components have been grouped into four categories, the main factor differentiating one group from the other being the manner in which the irradiating material will effect the containing vessel. Full details may be obtained in the publication, "Survey of Pressure Components for Land Based Nuclear Installations—Provisional Requirements, 1960" (£3 3s).

Portable Accelerator

The UKAEA have received a 4·3 MeV linear accelerator designed to make X-ray examinations of pressure vessels in nuclear power stations during their construction. The machine is believed to be the first completely mobile linear accelerator in the world. It will permit the welds in the 4 in thick steel spheres of the pressure vessels to be radiographed *in situ*, and will be used for the first time at the Trawsfynydd station. The accelerator is compact and weighs 2 tons. It has been designed and developed by Mullard Research Laboratories under a contract placed by the Authority.

Notes and News

Material Matters

Comprehensive manuals have been published on the three elements: aluminium, beryllium and plutonium. A detailed list of the mechanical, physical and chemical properties and thermal equilibrium diagrams are given for all three; in some cases they include the variations between the different isotopes of the element and its alloys. For aluminium and beryllium a table of irradiation effects is also provided. ("Aluminium Data Manual," compiled by B. J. Seddon. DEG Report 86 (R): "Plutonium Data Manual," compiled by E. L. Francis. IG Report 161 (RD/R) and "Beryllium Data Manual," compiled by E. L. Francis. IG Report 160 (RD/R)).

Cheaper Shield Design for Power Reactors

Reliable estimates have been made showing that substantial economic savings (in some cases more than £100,000 per reactor) could be achieved if accurate methods of calculation were available to the shield designer of industrial power plants. The UKAEA have published a report attempting to provide a set of recommended methods for shield design satisfying accuracy, ease of application and minimum use

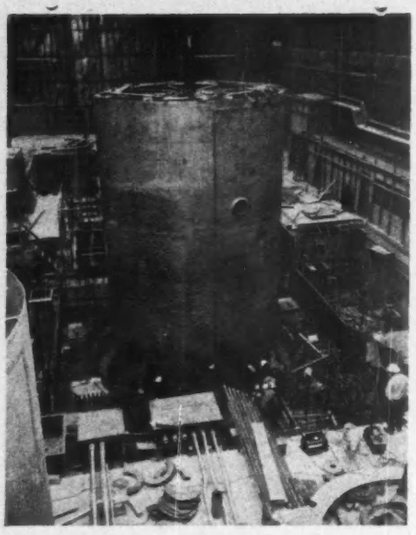


Fig. 3 The 65 ton reactor vessel for the 75 MW Hallam Project lowered into place. The vessel is 19 ft diameter, 33 ft high, and will contain the reactor core and the liquid sodium pool.

of empirical formulae. A section on method standardisation has also been included Multigroup theory is used since it correctly represents the asymptotic form of the neutron slowing-down density, providing the number of groups is sufficiently large. The multigroup approach also takes into account the rapid change in the neutron flux spectrum in the vicinity of interfaces between materials with differing moderating properties, for example, between iron and concrete; and secondly, because of scattering resonances in the cross-section of certain elements, neutrons can stream through large thicknesses without much attentuation. Suitable choice of the energy groups in a multigroup model can allow for this behaviour due to the long slowing-down lengths which will be assigned to these energy intervals. The use of multigroup theory calls for the services of a computer, and programme and operating instructions for the Ferranti "Mercury" computer have been included in appendices. Other topics dealt with in the report are nuclear heating, coolant activation, and fission-product energy decay rates. ("Methods of Calculation for Use in the Design of Shields of Power Reactors," by A F. Avery *et al.* AERE R-3216.)

Nuclear Ship Symposium

The outcome of the IAEA's symposium on nuclear ships showed that, providing certain precautions are taken, the risks due to the escape of radioactive materials can be kept to a minimum. It was clear that there was no prospect of having nuclear ships economically competitive with those using conventional power in the near future. However, it was urged that the economic gap was closing and it would be necessary and prudent to design, construct and operate nuclear ships so that valuable experience could be gained in the most effective way—by actual sea trials. Work must still be done on the method of waste disposal, shielding, internationally acceptable construction standards, and the effect of sea motion upon the ship.

New Authority Film

The UKAEA have made a new colour film called "R & D" (Research and Development) and aims at giving the layman a better understanding of some of the activities in the Authority's establishments at Culcheth, Springfields, Windscale and Capenhurst, and at Dounreay. The research programme for fuel elements in CEGB nuclear power stations and the prototype elements for new reactors is examined with reference to the fabrication of uranium oxide pellets. The fundamental work on beryllium and plutonium and the associated problems that each element exhibits are considered. The urgent solution of these problems is forcibly realised when the viewer sees the rapidly advanced stage of construction of the AGR at Windscale which is to use beryllium for the canning material. The running time of the film is 26 minutes and copies are available on free loan from the Film Library, UKAEA, 11 Charles Street, London, SW1.

Reports Received

Dissolution Rate of Zirconium Oxide: Rapid dissolution of about 15 per cent of the samples of neutron irradiated ZrO_2 has not been shown conclusively to be the result of displaced atoms in the oxide resulting from fast neutron irradiation. A change in the specific surface area resulting from the irradiation is the most probable cause. (K. Alcock and B. Cox: "The Oxidation and Corrosion of Zirconium and Its Alloys," Part 8, AERE-R3114.)

Temperature Measurements: Maximum can temperature cannot be measured in every channel, and the comparatively unusual method of statistical analysis to estimate the extreme values instead of mean values is discussed in a report which sets out some of the principles involved. ("Statistical Methods for the Estimation of Maximum Fuel Element Temperature," by A. Hitchcock. IGR-TN/R-760.)

Gaseous Thermal Properties: A revised standard set of values for the thermal conductivities, viscosities and specific heats of hydrogen, helium, nitrogen, argon, krypton, xenon, carbon dioxide, and air over the temperature range 0 to 1,000° C is given. Certain binary and tertiary gas mixtures are included. A selection of published work is reviewed and the values quoted are displayed in tabular and/or graphical form, from which standard graphs have been derived. ("Thermal Properties of Gases for Use in Reactor Heat Transfer Calculations," by G. V. Massey. DEG Report 14 (D).)

No Need for Transcendental Equations: A variational principle is given for spherical, cylindrical and slab reactors with one-group theory in the core and two-group in the reflector. The critical Laplacian of the core and the fluxes are determined by a Rayleigh-Ritz technique. To obtain an accuracy within 0·1 per cent in the critical Laplacian and 1 per cent in the flux the solution of a quadratic only is required instead of the transcendental equation of the standard theory. ("Variational Principle for Spherical, Cylindrical and Slab Reactors with One Group in the Core and Two Groups in the Reflector," by R. T. Ackroyd and M. A. Perks. IGR-TN/R-598.)

Resonance Integrals: Methods of calculating resonance integrals of finite dilution and temperature are given for both homogeneous and heterogeneous geometries, together with the results obtained from these methods when applied to the design of high-temperature reactors. ("Resonance Integral Calculations for High Temperature Reactors," by J. P. H. Blake. AEEW-R25.)

The 'Engineering' Appointments Section

THE NUCLEAR POWER GROUP

requires

ELECTRICAL AND MECHANICAL ENGINEERS

The Group, now actively engaged on the construction of four major nuclear power stations as well as designs for new plants in the United Kingdom and overseas, invites applications from engineers suitably qualified for the following positions:—

STATION AUXILIARY ELECTRICAL SYSTEMS

ONE SENIOR AND ONE JUNIOR ELECTRICAL ENGINEER for the design of the auxiliary power systems for conventional and reactor plant. Candidates should have several years experience in power station auxiliary electrical systems up to 11 kV and for the senior position should have a Degree in Electrical Engineering.

REACTOR CONTROL SYSTEMS

ONE ELECTRICAL ENGINEER to design reactor control equipment where very high standards of reliability are essential. Candidates should have a Degree in Electrical Engineering and several years experience on medium size rotating and static electrical plant. Experience in the design of industrial servo and precision motor control systems would be an advantage.

REACTOR CORE DESIGN

ONE MECHANICAL ENGINEER for heat transfer, stress and energy storage calculations associated with graphite in reactor cores. Candidates should have 2-3 years industrial experience and an Engineering Degree.

BURST FUEL CARTRIDGE DETECTION

ONE ELECTRICAL OR MECHANICAL ENGINEER for the design of monitoring equipment for the detection of Burst Fuel Cartridges. Candidates should have an Engineering Degree or equivalent qualification and at least 3 years experience in medium or light precision engineering.

REACTOR INSTRUMENTATION

ONE INSTRUMENT ENGINEER for the design of instrumentation schemes for nuclear power stations including comprehensive temperature and neutron flux measuring schemes. Candidates should have several years industrial instrumentation experience.

The Company operates a Contributory Pension Scheme and assistance with house purchase is given to married men.

Applications, giving full details of age, qualifications and experience, should be addressed to:—

THE PERSONNEL MANAGER
THE NUCLEAR POWER GROUP
RADBROKE HALL
KNUTSFORD
CHESHIRE

Quoting Reference E/ELEC/16. D 551

PUBLIC APPOINTMENTS

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

BURTON STREET, NOTTINGHAM

Principal: D. A. R. CLARK, M.Sc.(Tech.), M.I.Mech.E.

Applications are invited for the post of full-time RESEARCH ASSOCIATE IN MECHANICAL ENGINEERING. The person appointed will be expected to undertake research in one of the following fields: Vibration of Machine Tools; Vibration in Vehicles; Critical Speeds and Damping; Model Analysis in Production Processes; Heat Transfer; Fatigue; or Metal Cutting. Previous research experience is desirable but not essential. The post offers considerable scope, and encouragement will be given to obtain higher qualifications. The post is tenable for three years.

Salary: £650 by £50 to £750 per annum (under review).

Application forms and further particulars may be obtained from the PRINCIPAL, to whom completed forms should be returned not later than 23 December, 1960. D 542

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE HENDON TECHNICAL COLLEGE

The Burroughs, Hendon, London, N.W.4

Applications are invited for the post of SENIOR LECTURER in the MECHANICAL ENGINEERING DEPARTMENT of the above College.

Whilst it is necessary that applicants should be able to specialise in a mechanical engineering subject, the subject offered is of less importance than the general qualities of the applicant.

The courses in the department at present include Higher National Diploma, Higher National Certificate and Ordinary National Certificate in Mechanical Engineering, with some Aeronautical content; higher level courses are envisaged for the near future.

A good degree in mechanical engineering is required, preferably together with Corporate Membership of the Institution of Mechanical Engineers. Previous experience in academic work is desirable but not essential.

Special consideration can be given to applicants at present in industry who wish to make lecturing a career, but who have had little or no teaching experience.

Salary will be within the range £1588 to £1801 per annum.

Application forms and further information can be obtained from the CLERK TO THE GOVERNING BODY, TOWN HALL, HENDON, LONDON, N.W.4.

C. E. GURR, M.Sc., Ph.D.
Chief Education Officer. D 540

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

AIR MINISTRY require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEER for design construction and maintenance of installations on airfields, radar stations, missile bases, workshop and maintenance units for the R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to max. £1260 with increase for London and slight decrease for country districts. Appointments long term with promotion and pension prospects. Five-day week with 4 weeks 2 days leave a year initially. Special allowances payable in addition to salary during overseas service.

Minimum qualifications and experience:—

(i) (a) University degree or equiv. diploma in electrical and/or mechanical engineering with at least 2 years apprenticeship; or

(b) Graduate or corporate member of I.E.E. with at least 3 years apprenticeship; or

(c) Graduate or corporate member of I.Mech.E. appreciable electrical engineering experience with at least 3 years apprenticeship; and

(ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45.

Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.168/OA. G 897

STRUCTURAL ENGINEERING DESIGN DRAUGHTSMEN

AIR MINISTRY, Works Design Branch, requires in LONDON STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 2745), to AIR MINISTRY, W.G.4, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 894

CHIEF MECHANICAL ENGINEER

required by

Medium Sized Engineering Company for their Llanelly Factory.

To be responsible to General Management for the design and development of the Company's products.

Applicants must be between the ages of 30/40 years and have thorough knowledge of general engineering principles and capable of basic design thinking. A good working knowledge of the design and installation of underground mining machinery would be an advantage.

Please apply in writing giving full details of qualifications experience, present position held to:

General Manager,
Crawley Industrial Products Limited,
Llanelly, Carms.

D494

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

St. John Street, London, E.C.1

requires

LECTURERS or SENIOR LECTURERS with honours degrees and industrial or research experience for the following subjects:

MECHANICS OF FLUIDS

APPLIED THERMODYNAMICS

These vacancies arise from the continued expansion of the College in Degree, Diploma in Technology, and post-graduate studies.

Salary scales:

Senior Lecturer, £1588 rising to £1801.

Lecturer, £1408 rising to £1601

Particulars and forms of application are obtainable from the Secretary.

D 524

STATION ENGINEERS

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and MINISTRY OF AVIATION STATIONS throughout the United Kingdom. The work of Station Engineers (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineers (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment.

Candidates should hold O.N.C. Elec. or Mech./C. & G. Electrical Technicians Certificates/2nd Class M.O.T. Certificate, or equivalent, and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience.

Commencing salary, which is dependent upon age, qualifications and experience, ranges from £745 (age 25) to £925 maximum in Grade III. There are pension prospects and also opportunities of advancement to numerous posts in the higher grades vacancie. which, as a rule, are filled by promotion of Grade III staff, viz.:

Technical Grade II, £925-£1055	...	276 posts
Inspector of Works Grade I, £1055-£1295	...	137 posts
Technical Grade B, £1295-£1491	...	25 posts
Technical Grade A, £1385-£1630	...	17 posts

Overseas tours for which special allowances ranging at present up to £1800 p.a. are payable in addition to a higher salary. Internal training courses are provided and financial assistance and time off is allowed for recognised courses of study leading to higher qualifications. 5-day-week with 18 days paid leave a year initially.

Applicants, who must be natural born British subjects, up to age 55, should write stating age, qualifications and experience, to the MANAGER (P.E.1), MINISTRY OF LABOUR, PROFESSIONAL AND EXECUTIVE REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. No original testimonials should be sent. Candidates selected will normally be interviewed in London and certain expenses reimbursed. Only applicants selected for interview will be advised. G 903

MSL *have been retained to advise on the appointment of a*

COPY EXECUTIVE
Technical

for a well known engineering organisation which specialises in the production of technical and scientific literature and every kind of sales promotional aid and material used in the engineering, electrical, electronic and nuclear industries.

The copy executive will take over all responsibility for the writing of "copy" for technical press advertisements and sales promotion literature, the subjects covering the entire field of engineering and science. The standard of work required is exceptionally high and the man appointed will have adequate support from a large staff of specialist engineers.

Candidates must have:

1. A sound engineering background—preferably a recognised technical qualification.
2. The ability to write faultless English (including spelling, punctuation and grammar).
3. Practical knowledge of sales promotion in the technical field.

Experience in handling the publicity of a large engineering company desirable. Probable age 30 to 35. Initial salary up to £1,500 plus bonus and contributory pension scheme. Please send brief details in confidence quoting reference F.2694 to P. J. H. Fryer.

MANAGEMENT SELECTION LIMITED
17 Stratton Street, London, W.1.

In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

D 519

THANET WATER BOARD
SENIOR ENGINEERING ASSISTANT

Applications are invited for the above post on Salary Scale APT III—£960 to £1140, from persons with waterworks experience, preferably including mechanical and electrical work and suitable qualifications.

An interesting programme of work is envisaged, including the modernisation and construction of new pumping and booster stations and the development of a new source.

The appointment is subject to the provisions of the Local Government Superannuation Acts, the passing of a medical examination and is terminable by one month's notice on either side.

Housing accommodation is available to the successful applicant and 50 per cent removal expenses will be paid.

Further details and forms of application may be obtained from the ENGINEER AND MANAGER, THANET WATER BOARD, 58, VICTORIA ROAD, MARGATE, to whom completed forms should be addressed, endorsed "SENIOR ASSISTANT," not later than the 28th DECEMBER, 1960.

Canvassing directly or indirectly will disqualify.

D 539

THE UNIVERSITY OF LEEDS
DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the post of COMPUTATIONAL ASSISTANT in the Department of Mechanical Engineering at a salary within the range £750-£900 a year according to qualifications and experience. Applicants should have a degree in Mathematics or Engineering or a similar qualification. Experience of the use of an electronic computer would be useful but is not essential. The successful candidate would be required to use the University digital computer for work concerning the lubrication research which is going on within the department. This work is supported by the D.S.I.R. The appointment should not be expected to continue for more than three years.

Applications (three copies) stating date of birth, qualifications and experience, together with the names of three referees should reach the REGISTRAR, THE UNIVERSITY, LEEDS, 2 (from whom further particulars may be obtained) not later than 6th JANUARY, 1961. D 544

SENIOR STRUCTURAL DESIGN ENGINEER

An opportunity exists in a well known Company in the North East of England for a first class design engineer to take responsibility for the engineering of novel and complex structures. The successful candidate is likely to have a good honours degree in Mechanical, Civil or Aeronautical Engineering. He must have a young and flexible mind, a good knowledge of modern structural theory and practical techniques and the ability to apply his ideas to new and unconventional products.

The initial salary will depend on qualifications and experience but it is likely to be in the range £1600-£2000 per annum.

Please write giving full details of age, qualifications and experience to BOX D 557, Offices of ENGINEERING.

CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS NEW SOUTH WALES AUSTRALIA

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES, the State Road authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road constructions and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience will be within the range £A1325 to £A1650 per annum, with annual progression, subject to technical competence to £A2400 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the AGENT GENERAL FOR NEW SOUTH WALES, 56 STRAND, LONDON, W.C.2. Please quote NO. 44/31 when writing. D 545

AIR MINISTRY

AIR MINISTRY, Works Design Branch, requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—

(a) Roads, pavements, earthworks and storm-water drainage; (b) Foul drainage and sewage disposal; (c) Water supply distribution. Some site experience and possession of recognised technical qualifications an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially.

Salary ranges from £805 (at age 25) to £980 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write (quoting Order No. Kings Cross 3746), to AIR MINISTRY, W.G.d, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange, giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 895

AUSTRALIA

THE UNIVERSITY OF NEW SOUTH WALES

NEWCASTLE UNIVERSITY COLLEGE

VACANCIES FOR ACADEMIC STAFF

The University invites applications for appointment to the following positions at Newcastle University College:—

LECTURER IN CIVIL ENGINEERING
(to specialise in structures, fluid mechanics or surveying)
LECTURER IN MECHANICAL ENGINEERING

Salary range: £A1759-£A2464 p.a.

Subject to passing a medical examination, appointees will be eligible to contribute to the State Superannuation Fund.

First-class ship fares to Sydney of appointees and their families will be paid.

Four copies of applications, including the names of two referees, should be lodged with the Agent General for New South Wales, 56 Strand, London, W.C.2, and a copy forwarded by airmail in an envelope marked "University Appointments" to the BURSAR, THE UNIVERSITY OF NEW SOUTH WALES, BOX 1, POST OFFICE, KENSINGTON, NEW SOUTH WALES, AUSTRALIA, before 13th JANUARY, 1961. Candidates outside the United Kingdom and Ireland need only submit one copy of their applications to the London address. D 558

UNITED KINGDOM TECHNICAL ASSISTANCE

Applications are invited for an appointment as ADVISER IN THE MANUFACTURE OF LABORATORY AND SCIENTIFIC EQUIPMENT, INDIA, to advise in the manufacture of laboratory equipment consisting of metallic articles like physical balances, scales, gauges, precision instruments and laboratory fittings. Applicants must be experienced in the manufacture of laboratory equipment with particular practical experience of the above items. Salary £3500 p.a. plus generous tax free allowances. All emoluments paid by British Government. Duration three years.—For further information and application form write to MINISTRY OF LABOUR (E.9), 26-28 KING STREET, LONDON, S.W.1, quoting TCS/IND/743. D 553

UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF ELECTRICAL ENGINEERING. Applications are invited for the post of LECTURER or ASSISTANT LECTURER in Electrical Engineering. Salary Scales: Lecturer, £1050 by £50 to £1400 by £75 to £1850 with an efficiency bar at £1475. Assistant Lecturer, £800 by £50 to £950. The initial salary will depend on qualifications and experience.

Further particulars should be obtained from the SECRETARY AND REGISTRAR to whom applications (7 copies from United Kingdom applicants) should be sent not later than 31 JANUARY, 1961. D 555

PRINCIPAL HYDROLOGICAL ENGINEER

Required by the FEDERAL GOVERNMENT OF NIGERIA to be responsible for all hydrological studies including level predictions and calculations in respect of all hydrological measurements, also to undertake frequent inspections in the field and supervise the training of junior staff.

Candidates must hold a degree in Civil Engineering or be A.M.I.C.E. with particular qualifications or diplomas in hydrology and hydraulics and must have had considerable experience in river hydrology and engineering. Contract appointment for one tour of 12-18 months in the first instance with prospects of re-engagement. Salary £2748 per annum plus gratuity of £150 per annum for satisfactory service. Liberal leave on full pay. Free passages for officer and wife by air or sea. Quarters at low rent. Income Tax at low local rate. Children's allowances while separated.

Candidates should write for application forms and further particulars, stating age, qualifications and experience, to the

Appointments Secretary,
Federal Public Service Commission,
Nigeria House,
9, Northumberland Avenue,
London W.C.2.

quoting M.1/11. D 554

THE NUCLEAR POWER GROUP

requires

PROJECTS

and

PLANNING ENGINEERS

The Group, now engaged on the construction of four major nuclear power stations in the United Kingdom and overseas, invites applications from suitably experienced men for positions in its PROJECTS DEPARTMENT.

PROJECTS ENGINEERS

Vacancies exist for Mechanical, Electrical and Civil Engineers, to assist in the preparation of large contracts for plant and equipment. The duties comprise co-ordination of tenders, preparation of enquiries and orders for major plant and subsequent instructions to contractors during manufacture and construction. Previous experience of large engineering contracts, preferably in the power industry, is necessary. Candidates should be members of an engineering institution or possess exempting qualifications.

PLANNING ENGINEERS

The work involves preparation of overall programmes, from tender to final completion of power station projects. Site construction experience and also some experience in planning, involving co-ordination of major engineering contracts, is desirable, and candidates should be members of an engineering institution or possess exempting qualifications.

The Company operates a Contributory Pension Scheme, and assistance with house purchase is given to married men.

Applications, giving full details of age, qualifications and experience, should be addressed to:—

THE PERSONNEL MANAGER
THE NUCLEAR POWER GROUP
RADBROKE HALL
KNUTSFORD
CHESHIRE

Quoting Reference E/PROJ/15. D 552

METALS DIVISION

GRADUATE MECHANICAL ENGINEERS OR PHYSICISTS

of British nationality are required for SENIOR posts in the Engineering Group of the Research Department at WITTON, near Birmingham, to undertake work in the first instance in the following fields:—

STRENGTH of MATERIALS — The principal responsibility of senior staff is the development of equipment and procedures for new determinations of mechanical properties and the general analysis of the behaviour of materials. A wide range of plant is available and some supervision of conventional work is involved. Emphasis in the immediate future is likely to be on creep behaviour under stress systems more complex than constant tension.

DEFORMATION of METALS — The work covers principally the plastic behaviour of metal in both practical and theoretical aspects. Both process and product research is involved. Processes are almost wholly mechanical in nature. Excellent semi-technical plant and resources for the erection and testing of prototype units exist.

These posts hold good prospects of advancement both within the Research Department and in other positions of the organisations, to which technically qualified staff are frequently transferred.

Applicants should have a 1st or 2nd Class Honours Degree of a British University. Relevant experience is not necessary although a period of research work either at a University or in industry would be an advantage.

Initially, salary will depend on age, experience and qualifications and there is adequate scope for progressive remuneration. There is a Staff Pension Fund and an Employee Profit-Sharing Scheme. Assistance can be given towards house purchase and removal expenses for married men.

Please write for an application form to the

Personnel Manager (Staff)
IMPERIAL CHEMICAL INDUSTRIES LIMITED
Metals Division, P.O. Box 216
Kynoch Works, Witton, Birmingham, 6

quoting RES/458/ENG. D 556

SENIOR STAFF TECHNICIAN

A vacancy exists in our Central London Design Office for a man with initiative and ability to undertake work on a very wide variety of engineering problems.

The position would appeal to an experienced aircraft stressman wishing to escape from specialisation and keen to accept a high degree of individual responsibility.

Familiarity with structural engineering requirements would be an advantage. Write to:—

Design Director
MICROCELL LTD.
9 KINGSWAY, W.C.2

D 543

ATOMIC ENERGY RESEARCH

ESTABLISHMENT, HARWELL, BERKS

requires

PROFESSIONAL ENGINEERS

in the

ENGINEERING DIVISION

to take charge of the engineering organisations serving the Chemical Engineering and Chemistry Divisions and to provide a comprehensive service including:—

(i) Control of local engineering workshops.
(ii) Erection and modification of experimental plant and equipment.
(iii) Ad hoc design and construction of experimental equipment.
(iv) Plant operation and maintenance.
(v) Safety of engineering plant and operations.

SALARY: £1370-£1825 p.a., or £860 (at age 25)-£1340 p.a., according to age and experience.

Applicants should have served a recognised engineering apprenticeship or have had equivalent training and be corporate members of a senior engineering institution or have equivalent qualifications.

Good experience in the fields of general engineering and industrial management is essential. The possession of an Engineering Degree and experience in the Chemical Engineering field would be advantageous.

Instruction given in the technology of working with radioactive materials.

Superannuation and housing schemes.

Send POSTCARD for details to the PERSONNEL MANAGER (1837/26), U.K.A.E.A., A.E.R.E., HARWELL, DIDCOT, BERKS. D 550

APPOINTMENTS OPEN

DRAUGHTSMAN

DRAUGHTSMAN required by the British Drug Houses Ltd., preferably with experience in Plant Layout and Special Purpose Machine Design. Must be able to take Site Dimensions. O.N.C. minimum qualification. Five-day week, Canteen, Sports Club, Pension and Profit Sharing Schemes.—Apply in writing stating age, experience and salary required to the PERSONNEL MANAGER (LKA), GRAHAM STREET, CITY ROAD, N.1. D 531

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANT required for the JAMAICA OFFICE OF NORMAN & DAWBARN, ARCHITECTS AND CONSULTING ENGINEERS, 7, PORTLAND PLACE, LONDON, W.1, for civil engineering work associated with varied building projects including airports and factories.—Written applications giving age, experience and qualifications are required. Salary plus allowances from £1850 to £2300 p.a. D 508

ENGINEER SURVEYORS

ENGINEER SURVEYORS for the inspection of boiler and pressure plant required. Applicants should not be more than 36 years and must have 1st Class M.O.T. Certificate with steam endorsement or equivalent qualifications. Salary E.S.A. Scale starting at £825 rising to £1225 per annum. Other benefits. Areas: Shrewsbury, Windsor, Reading, Oxford.—Write ENG. DEPT., GENERAL ACCIDENT ASSURANCE CORP., LTD., 99, ALDWYCH, W.C.2. D 549

UNITED KINGDOM

ATOMIC ENERGY AUTHORITY

requires

DESIGN ENGINEERS

to work in close liaison with scientific staff on the design of experimental facilities and equipment for the Materials Testing Reactor at Dounreay.

Applicants must have served a recognised engineering apprenticeship and be at least graduate members of a senior engineering institution, or have an honours degree in engineering with at least three years' experience of light mechanical engineering.

Salary assessed between £860 and £1825 according to age, qualifications and experience.

Housing assistance schemes. Hostel accommodation. Contributory Superannuation.

Send for Application Form to PERSONNEL MANAGER, U.K.A.E.A., DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT, THURSO, CAITHNESS, quoting Ref. 162/26.

D 538

ASSISTANT CHIEF ENGINEER

ASSISTANT CHIEF ENGINEER required for Engineering Office on North East Coast. The work of the Company is connected with the design and construction of industrial power stations and general mechanical/electrification work and demands a knowledgeable and keen man between 35 and 45 years of age. The applicant must be a graduate or chartered mechanical/electrical engineer used to leadership and with a good experience in Contract work. Ability to work harmoniously yet firmly with existing staff is essential.

Contributory Superannuation Scheme in operation.

Reply giving full details of present salary and previous experience to BOX D 547, Offices of ENGINEERING.

MECHANICAL ENGINEERING GRADUATE

required for the design of centrifugal pumps. Honours graduate with some experience preferred but applications from graduates without design experience who have had suitable technical training will be considered. Interesting work with good prospects. Full details of training, experience, age, etc. to

PERSONNEL MANAGER,
The Harland Engineering Co. Ltd.,
Alloa

D 548

DESIGN ENGINEERS

Vacancies occur in the Mechanical Design Section of the Process Plants Division of Foster Wheeler Limited. The work involves the mechanical design of Heat Exchangers, Pressure Vessels, Process Piping (including thermal analysis), and the various special problems which arise in the design of Oil Refinery and Chemical Plant.

Preference given to a Graduate Engineer having a minimum of two years' industrial experience, versatile, and with an aptitude for design. The position provides a wide range of interest, with full scope for original work in an integrated group. Salary will be commensurate with qualifications and experience. Pension and Life Assurance Scheme.

Write fully age, qualifications and experience to:—

STAFF DEPARTMENT (M.D.O.D.),
FOSTER WHEELER LTD.,
3, Ixworth Place, London, S.W.3.

D 560

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent, on 52.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Company Meetings

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

British and South African Companies Cooperate

A SOUTH AFRICAN company which has strong links with firms in the United Kingdom has recently issued its annual report, underlining the current difficulties in the country but indicating the manner in which with its British associates the framework is being laid for considerable expansion in the future.

The company is the VANDERBIJL ENGINEERING CORPORATION, which for the year ending 30 June showed a profit after tax of £426,676 (£22,000 above the year before). This increased profit was produced despite very sharply increased competitiveness in the South African engineering industries.

A decrease in the volume of work available has resulted in a £500,000 fall in the value of orders in hand at 30 June this year compared with the position twelve months earlier. This is thought by the company to be only a short term trend and not to reflect any long term developments.

An agreement was concluded during the year with RUBERY OWEN, of Darlaston, to cooperate in production and sale of passenger car and commercial vehicle components in South Africa. A new company RUBEROWEN (SOUTH AFRICA) was formed in May with VECOR, part of the Vanderbijl concern, holding 51 per cent of the shares.

Vanderbijl have also acquired South African interests and manufacturing facilities from BABCOCK AND WILCOX and entered into commercial and technical agreements with the company.

All these moves and the extension of manufacturing facilities have led to the recommendation to increase the capital from £4 million to £6 million. This is to be done by issuing 400,000 additional £1 ordinary shares to Babcock and Wilcox and 1,600,000 to the existing shareholders.

The Herald Story from Handley Page

Much of Sir Frederick Handley Page's review of the HANDLEY PAGE Company's affairs in 1959 is concerned with the Dart Herald—the short-haul transport whose high profit earning potential has already brought in orders from BRITISH EUROPEAN AIRWAYS and the JERSEY AIRLINES.

A demonstration Dart Herald has so far put in over 175,000 miles of intensive sales touring, visiting 53 countries and carrying 11,900 passengers through some 779 flying hours.

Jersey Airlines have ordered six Heralds and their managing director has commented that his firm evaluated all the prop-jet aircraft in the short-haul field and could find none offering such a high profit-potential over the short stage-lengths of the Channel Island to mainland services.

The Heralds for Jersey and for BEA are in production. BEA's are expected to go into service early in the New Year.

More than a little has been heard in the past year of the opportunities for British trade in South America. Handley Page put in a sales tour with their Herald and serious inquiries from the area exceed 60 aircraft. Airlines in Argentina and Brazil have stated that they will buy at least 16.

The other wing of the Handley Page operation is the Victor bomber. Production for the Royal Air Force has been the main activity of the company through the year. The more advanced Victor II is shortly to join the established Victor Is in squadron service.

Reconditioning Hastings transports for the RAF and Hermes aircraft for independent airline operators is also a significant part of the company's business. The 13 year old Hastings are believed to have plenty of life in them yet.

Research Targets

Handley Page research is aimed at two principal targets, "sophisticated supersonic" airliners and fast subsonic aircraft capable of economically competing with surface transport. Under a Ministry of Aviation contract the company is building a small research aircraft for important work into the behaviour of very fast aircraft at low speeds.

The company's design teams are doing development work for very large laminar-flow airliners. The suppression of turbulence gives a decrease in drag which leads to previously unattainable improvements in range and load carrying capacity and reductions in operating costs and in noise.

Applying laminar techniques to a supersonic, arrowheaded airliner would add 50 per cent to its payload, or increase the range by about a third with the same payload. Handley Page have recently been in discussion with MCDONNELL AIRCRAFT, of Missouri, USA. The outcome could be a more rapid approach to putting such a plane in the air.

BSA Confidence Despite Uncertain Conditions

The current financial year includes the centenary of the BIRMINGHAM SMALL ARMS Company. The celebrations can hardly take place in an atmosphere of unrestrained optimism about the immediate future.

Yet the profits in the year which ended this July were a record (34 per cent up on the year before) and the chairman, Mr. John Y. Sangster, believes it reasonable to expect that trading profits of the current year will be comparable to those just reported.

The 24 company group had some solid successes in the past year. Sales of its motor cycles and scooters improved by 22 per cent on the previous year. Despite the serious handicap of labour shortage there was a considerable increase in the turnover in this field, breaking the previous almost-monopoly in scooters held by continental manufacturers. Production plans have been laid for providing an increasing proportion of the home sales.

The current financial year began with group motor cycle and scooter sales above the level of the equivalent period twelve months earlier but total new registrations in the UK in the same weeks are down by 32 per cent due to hire purchase restrictions imposed in April.

A third of the motor cycle production is exported and there is some confidence that this position will be maintained in the face of ever increasing competition.

In machine tools and in small tools both the home and export markets have shown a strong upswing so that the outstanding orders have gone up 300 per cent during the year. In addition to large orders from the motor industry a major contribution to this demand came from manufacturers of electrical and other domestic appliances.

Turnover in this section was 10 per cent above that of the year preceding and is now 25 per cent above that of a year ago. Machine tool exports to North America have increased substantially and total machine tool exports are as much as 22 per cent of total sales.

Acknowledging certain disquieting trends, Mr. Sangster reports no slackening in machine and small tool demand at the time of his review.

While almost every subsidiary substantially increased its turnover, the slowest revival came in products for the capital goods industry. This was particularly so in heavy steel forgings and steel castings, but there is now a more encouraging outlook here too.

Sales by the JESSOP-SAVILLE STEEL subsidiary reached 23 per cent above those of the previous year and were only a little short of the record year—1957. Orders on hand at the close of the year were 50 per cent higher than twelve months earlier. Continuation of the present level of demand could produce a record sales figure in the current year.

Mr. Sangster qualified his expectations on the current year's results with the observation that the trading outlook is in some ways more uncertain than for some years.

A New Machine Tool Northern Headquarters

The CHARLES CHURCHILL machine tool company seized the opportunity of the opening of their new building in Manchester to proclaim some of their recent successes and to rebut some of the criticism aimed at them.

Striking an optimistic note, Mr. Ralph Gabriel (inset), the managing director, declared that the tide of prosperity in Britain is not "near its ebb" and that recessions in overseas markets were temporary.

There has been some Press criticism of the company over its recent substantial machine tool order from Japan. Such criticism, with its misunderstanding of international economics, was not helpful, either to the machine tool industry or to the nation.

Mr. Gabriel described Sir Steuart Mitchell's sub-committee on the machine tool industry as having shown the false basis of Professor Melman's theories. Recognition had been given to the need for machines individually suited to the customers' requirements and the false economy of cheap machine tools exposed.

What industry wanted was machine tools processing parts at the cheapest price per unit. The machine's initial cost was only of secondary importance.

The functionally designed storage, warehousing and dispatch facilities of the new building are strong evidence that the Charles Churchill company, while applying itself to overseas markets, is keeping a close eye on its services to industry at home.

Appliance Retailers' Long Term Confidence

Present suffering from credit restrictions and confidence in long term growth and prosperity are the keynotes of a great many statements and bulletins from all manner of companies.

Looking strongly to the future is the annual report of Mr. D. G. Nairn, chairman of J. AND F. STONE LIGHTING AND RADIO Limited. Though the credit turnover of the company's shops has slowed down considerably the cash sales have risen. Due to the effects of the release of credit restrictions, before their reimposition in April of this year, the financial year which ended on 30 June shows a profit of £802,769 against £526,775 in the previous year.

Mr. Nairn reports that the flow of money through the branches is still measured by the larger volume of credit transactions embarked upon before the controls were brought down again. Since the profits are related to the flow of money there has not been any decline in current profits, but if the restrictions are not again lifted there is bound to be a tendency for the profits to recede as the flow of money slows down.

In the course of the year 11 shops were bought and the company "would not be averse to acquiring a group of stores should the opportunity present itself." Considerable sums are to be spent on modernising a number of existing branches.

Belgian Arms Maker Busy for NATO and Britain

Demand from NATO for ammunition, the British Army's adoption of the new MAG58 machine gun, and the development of the new AS24 lightweight vehicle designed for dropping by parachute all contributed to an active year for the Belgian armament and nuclear engineering firm, FABRIQUE NATIONALE D'ARMES DE GUERRE, of Herstal-lez-Liège.

In their annual report the company say that despite the ending of jet engine production the total turnover remained satisfactory, due to increasing activity in the armaments division.

The armament division found a growing demand for Browning shotguns and pistols and was producing light military equipment such as the Light Auto rifle, and the MAG58 to be used by Britain. Monthly output of ammunition was running at 10 million rounds a month throughout the year, much of the demand being that from NATO for 7·62 mm ammunition.

The company's general engineering division is now preparing for the manufacture under licence of J70 jet engines, beginning in 1962. Cooperating with other Benelux powers Fabrique Nationale d'Armes de Guerre will help erect launching ramps for Hawk missiles.

The Monorail Transporter

From initial scepticism, the attitude of civil engineers changed to enthusiasm as the potential of the capable monorail was recognised.

IN THESE days of increasing intricacy and refinement in the design of engineering products, it is rare to find one which wins the day on a simplicity which makes no concessions to fashionable streamlining or styling.

The contractors' monorail transporter as developed in recent years by Road Machines (Drayton) Limited, of West Drayton, Middlesex, is the simplest form of light railway imaginable. There is no locomotive and no driver—the "train" is started and automatically stopped from the track side. There is only one rail, and it is so mounted that site preparation is eliminated. This convenient simplicity contrasts sharply with the preliminary work required for a conventional two-rail system, or a roadway for the passage of lorries and dumpers. And it is more economical than wheelbarrows.

The monorail is the result of a complete rethink in the field of site material transporting. It proves once again that there is still plenty of scope for an original and imaginative approach to current technical problems. The gradual process of improving and refining existing products in order to improve their performance and versatility is not sufficient in itself. Sometimes it pays off to return to the heart of the problem and start from scratch with something entirely new. In the monorail transporter, a long-established principle has been put to a new use, with startlingly successful results.

The credit for first realising the monorail's potential on construction sites goes to Mr. William Muir Robb, chairman and managing director of the Muir Robb group of companies, of which Road Machines is the parent. Mr. Robb envisaged the monorail as a means of conveying wet concrete from a batch mixing station to the various pouring points on the site. Development work was started by Road Machines shortly after the war, and the first machine was sold in June, 1949. Although its eventual success as a means of conveying concrete was to some extent expected, the many other uses which have been found for the monorail, particularly off the site, were entirely unforeseen.

The timeliness of the advent of the monorail transporter has been a key factor in its success. Britain's postwar rebuilding programme did not really get into its stride until after 1950, when the monorail was still in its infancy.

Today the centres of many towns and cities in Britain are being transformed by the building of huge blocks of offices and flats. New road construction and local road improvements have also started on a large scale, and to meet this expansion civil engineers have had to arm themselves with increasing quantities of up-to-date mechanical equipment. The monorail has therefore grown up in a world of quickening activity, with a watchful eye on rising costs.

MONORAIL VEHICLES

The monorail transporter consists of a power wagon with tipping skip mounted on the same chassis. One, or in the latest type two, trailers can be towed or propelled by the power wagon. Trailers are also readily convertible to power wagons. They are carried on two double-flanged wheels running along the top flange of the track rail (Fig. 1). This wheel arrangement is common to either a power or carrying unit, and in both cases the unit swivels to suit curves. Stability is maintained by means of rollers bearing on the lower rail flange, and rail guide rollers acting on the top flange provide the swivelling action. In the first few prototypes the stabilising rollers were spring loaded against the rail but this was discarded in favour of rubber cushion mounting with adjustment to take up wear.

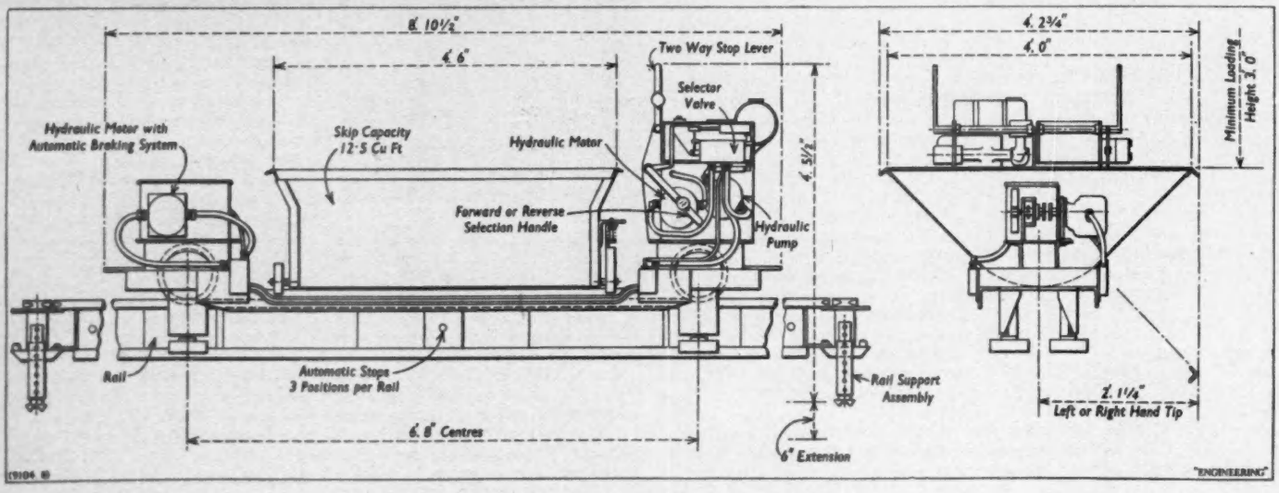
As might be expected with such a simple machine, the monorail transporter has not changed much since birth, but in 1958 hydraulic drive was introduced in the power wagon as an alternative to mechanical. The reason lies in the lack of adhesion between wheel and rail when only one wheel is driven. In the hydraulic version, known as the Mark II, both wheels are driven. The engine drives a pump from which hydraulic power is transmitted to a motor on each wheel. Thus the weight and contact area available for adhesion are increased considerably. At the same time a more powerful engine was fitted, and the combination of these two factors led to an improvement in the weakest spot in the monorail's performance, namely, its climbing ability.

The Mark II is specified as being capable of climbing a slope of 1 in 9 fully loaded without a trailer, 1 in 17 with one trailer and 1 in 28 with two. The Mark 1 can only handle one trailer, and corresponding figures are 1 in 12, and 1 in 18. Running speed in both cases is about 3½ m.p.h.

The Mark I with mechanical drive now has the same engine as the Mark II, and still accounts for about 10 per cent of monorail production. This year an improvement was made to the drive arrangements of the Mark I, the primary belt having been replaced by gears. It eliminated

Fig. 1 (left) The heart of the monorail transporter: driving wheel, stabilising rollers and guide rollers.

Fig. 2 (below) Outline of Mark II power wagon.



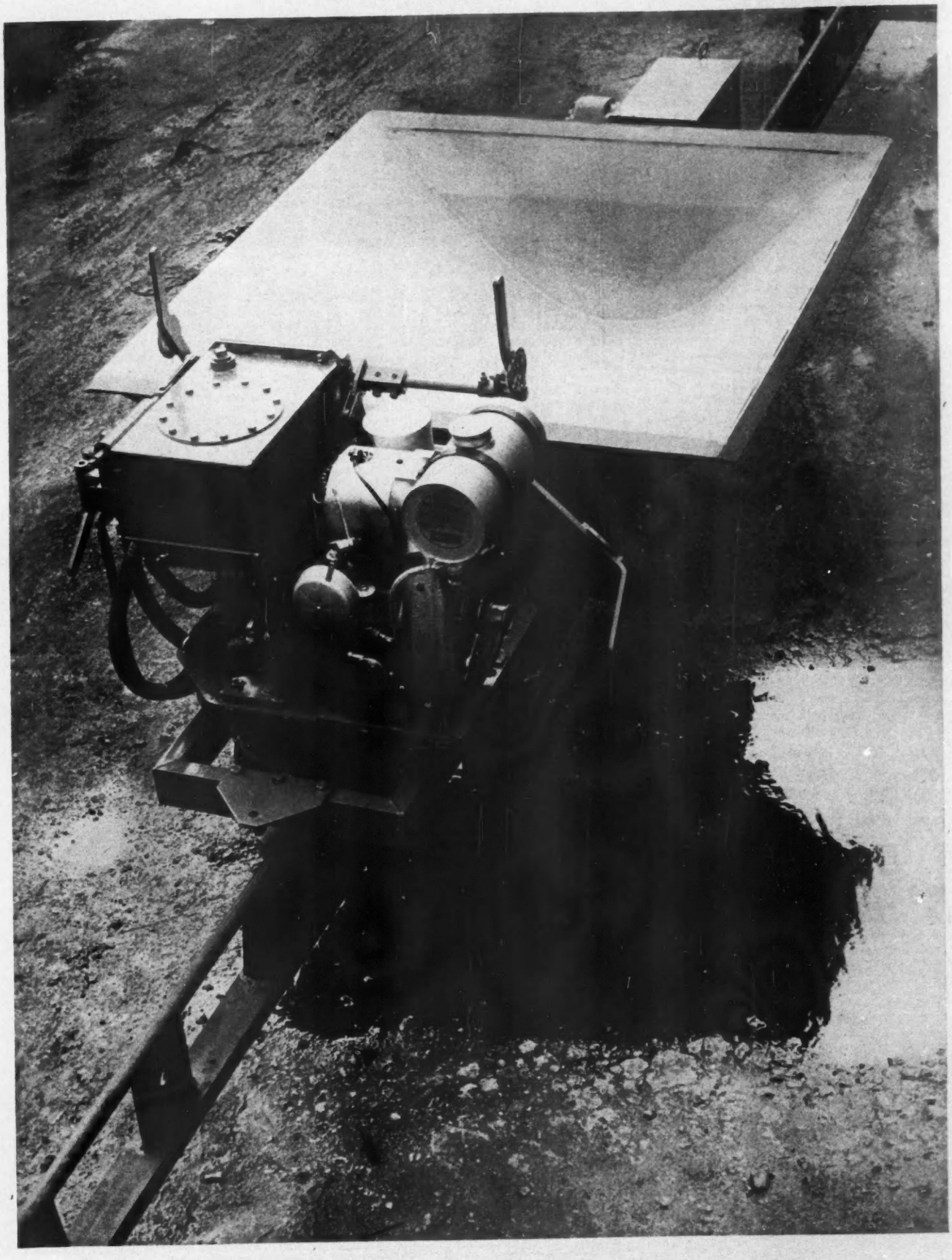


Fig. 3 Simplicity, ruggedness and driverless control: they are all here.

loss of power due to the belt slipping, and although a simple matter to remedy, it led to unjustified complaints. The Mark I power wagon costs £395 and the Mark II £495.

The skip can be tipped to either side after releasing a catch. Skip capacity in terms of water measure is 12½ cu. ft, equivalent to 12 cu. ft of wet concrete leaving ½ cu. ft freeboard. Earlier models had a slightly smaller capacity, but customers wanted more. The skip is so balanced that one man can discharge it when it is fully loaded Two men are employed if any degree of control over the rate of tipping is necessary; for example, when pouring concrete into a complicated system of steel reinforcement where a sudden rush of concrete might distort the bars.

The standard engine for this country is a 412 c.c. 7½ b.h.p. JAP air-cooled 4-stroke petrol engine. Other makes are sometimes specified for overseas; for example, the Mark II shown in Fig. 3 is fitted with a Sitchell and Sachs engine and is part of an export order to Germany.

One of the beauties of the monorail operationally is its small manpower requirement. Once the engine is running, the man at the loading point has merely to move a lever on the engine unit to set the machine in motion. When it reaches the pouring point a removable track stop engages a contact shoe beneath the engine unit and brings the machine to rest. The controls are simple, robust and foolproof. A lever duplicated both sides of the engine unit controls the clutch and brake, and the throttle is controlled by a governor. Direction of travel is selected by a second duplicated lever.

The track stop can be of two types. One will stop the transporter in both directions and is generally employed at loading and pouring points where the track is arranged as a continuous circuit. It will automatically stop the machine at once if, by mistake, it is set in motion in the wrong direction. The other type will stop the machine in one direction only, and is useful on a there-and-back system. It can also be used as a safety device with more than one train to ensure that they run in the same direction.

TRACK

The track consists of a number of monorail sections supported at each end by a two-leg rail stand. Rails are supplied in standard lengths, the curves being of 12 ft radius. Foot-operated points are used where a junction is required. Each rail is linked to the stand by a simple pin connection, see Fig. 4. The top of the stand is so shaped that it fills the gap between the rail ends and presents almost continuous running surfaces for the carrying wheels and guide rollers.

Rail stands are supplied in three different standard heights, and individual leg adjustment is provided to suit the contour of the site. Over soft ground, plates or timbers are used beneath the feet. In extreme cases the track may be built on trestles, or attached to tubular steel scaffolding, by using special U-shaped feet.

Fig. 4 Laying the track is a simple operation.

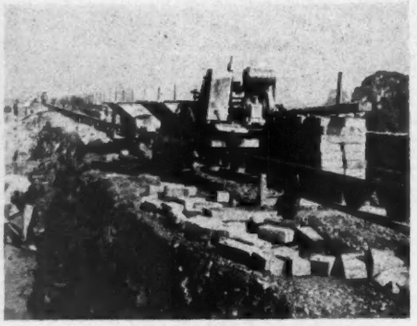
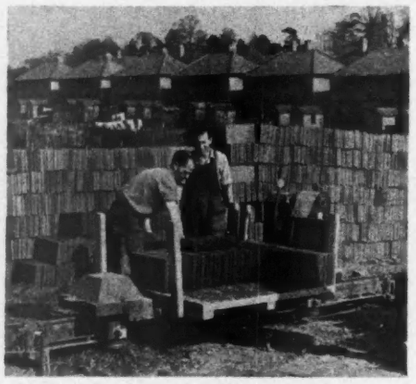


Fig. 5 Installation alongside a busy railway line.

Fig. 6 (below) The monorail is readily adaptable.



There is virtually no limit to the variety of mounting arrangements that may be adopted. This factor, coupled with the ease with which the track may be lifted, extended or re-routed, gives the monorail a certain advantage over other forms of site transportation. The advantage is, however, sometimes offset by the relatively high cost of the track, which in standard form costs about £1 per foot run. The rails have to be light and portable, yet robust.

Apart from taking the weight of the transporter, which can impose a maximum wheel loading of about ¾ ton, the rails also provide a stabilising moment. This is considerable even when the loaded transporter is running normally along the level, and is still greater at the instant of skip tipping. The track is also vulnerable to damage by other items of moving equipment or during removal to another site. Rail kinking can only be caused by maltreatment.

Road Machines have taken pains to make the rails more robust, while at the same time keeping down weight and cost. Originally the top flange and bottom flanges were welded to a web formed of thin plate, but vehicle weight and capacity have since increased. The present web design takes the form of a non-continuous fabricated box section which offers a reasonable strength-to-weight relationship.

THE FUTURE

What are the present-day factors which influence the civil engineer in deciding whether he is going to install a monorail? Primarily, the site conditions. If the ground is firm and well drained, and there is good access and plenty of room for dumpers to move around, then these are what he will probably use.

Convenient sites are the exception rather than the rule, and that is one of the reasons why the monorail transporter is coming into its own. The muddy and awkward site with very restricted clearances is just the place for it. As the drawing shows, it can pass through an opening barely 4 ft 6 in square; and its very unobtrusiveness is one of its main characteristics.

To get the best use of the monorail, it should not be asked to negotiate slopes greater than those quoted by Road Machines. To allow for well worn and greasy rails it is advisable to leave something in reserve. Also, a continuous loop is more satisfactory than a straight there-and-back route, particularly for longer distances using more than one "train."

Pouring concrete over large areas is sometimes a problem with a monorail, since the stand feet tend to interfere with any reinforcement. To overcome this, Road Machines have developed the "bridge" system, see Fig. 7. Here a line of track is laid down each side of the slab to be poured. The bridge spans between the tracks and carries the transporter across the slab. It incorporates curved "run up" sections of track and can be moved bodily, thus giving complete coverage. As it runs on rail wheels it takes only a few moments to reposition.

The monorail can now be found on the strength of all leading civil engineering contractors and plant hire firms in this country, and many abroad. In Britain sales are direct, but sales overseas are through a world-wide chain of distributors. Roughly 50 per cent are produced for overseas markets, and business has been particularly successful in France, Germany and South Africa, where Road Machines have established their own companies. In the United States the monorail is built under licence as the Rex Railporter. Monorails are also sold in Iron Curtain countries through a subsidiary.

With a transportation system of such basic simplicity, any design changes must be critically considered lest they destroy its character. Extending the hydraulics of the Mark II to provide controlled tipping is the latest development. From there the next step might be to motorise the trailer wheels.

Fig. 7 Using the bridge method of pouring concrete over a large reinforced slab. The bridge is carried on the monorail track. The power wagon is a Mark I.

Space-Simulator Laboratory for Satellite Research

A new $8 million laboratory is being built by the Lockheed Aircraft Corporation in the USA for research in the field of satellites and rockets. At the same time in other expansion moves, Lockheed's "space" organisation plans to increase its staff and to lease 100,000 ft of floor space for additional development and engineering work. Most elaborate of the facilities is the Hivos (high vacuum orbital simulator), a piece of space test equipment large enough to hold an entire satellite or space craft under simulated space conditions. Lockheed is currently building both satellites and space craft versions of its Agena vehicle for the United States Air Force and for the National Aeronautics and Space Administration.

The orbital simulator will duplicate the vacuum of space at 200 miles out from the earth. It will help with investigations into what happens to satellites and space craft over long periods in orbit. It will also be able to duplicate the heat absorbed from the radiation of the sun in space, and the freezing, near absolute zero cold of space within the shadow of the earth.

The "space chamber" will be housed in a 90 ft high structure attached to Lockheed's satellite centre building at Sunnyvale, California, and is scheduled for completion in August 1961. Another new construction calls for a $4 million, 172,800 sq. ft engineering and laboratory building to be completed by next June.

Lockheed's "Space" Division currently employs more than 15,000 people at its 610 sq. acre Sunnyvale plant, while another 800 are scattered at leased facilities in the immediate area. Another 1,500 scientists and technicians work at research laboratories in Palo Alto and 600 employees are at the Division's nearby Santa Cruz mountain test base.

Operations of the $3·5 million Hivos space chamber will be automatically programmed and controlled. It will have a low speed digital data acquisition system for recording the temperature environment as well as to check on vehicle functions. Hivos checkout equipment will be similar to that used by Lockheed in ordinary in-the-atmosphere pre-orbit tests of satellites. It will allow space vehicles to run electronically through their entire operating programme under near-actual space conditions. Twenty-two 32 in diameter diffusion pumps and eight backing pumps will be used to maintain vacuum.

The space chamber will be able to accommodate a satellite 8 ft in diameter and 15 ft long. With expansion it will hold space craft up to 10 ft in diameter and 32 ft in length. Sun's heat in space will be simulated by panels of quartz lamps located close to the outer surface of the satellite. Walls of the chamber will be cooled by liquid nitrogen, down as far as −320° F.

Liquid Metal Fuel Cell Developed

A liquid metal fuel cell that has been run continuously for an hour in proof-of-principle research may point the way to a powerful yet compact electrical system for space-age applications, report scientists at Allison Division of General Motors, USA.

Fuel cells are now well known as devices for converting chemical energy directly into electrical energy. But, according to a report from General Motors, this is the first time that actual operation of a thermally regenerative fuel cell has been achieved.

Because it has no moving parts, such a system may fulfill the extremely high reliability standards required for space equipment.

Improved versions of the small laboratory model under development by Allison may in their final configuration be as much as ten times smaller than other types of fuel cells producing equivalent electrical output.

Liquid metal fuel cells, depending on size, would be capable of producing various amounts of power. Mobile or stationary, they could operate in conjunction with a heat source similar to the mobile compact nuclear reactor now being developed jointly by Allison and Nuclear Development Corporation of America under the direct supervision of the Atomic Energy Commission.

Using the nuclear conversion process under development at Allison, a reactor would be cooled with liquid metals, through providing a heat source for the regenerative fuel cell. Heating would cause the metals to separate at their various boiling temperatures. Their recombination would result in creation of an electrical current which could eventually provide power for submarines, remote military bases, barge-borne emergency power sources and the electro-jet propulsion systems of the future.

Successful Trials with VTOL Fighter

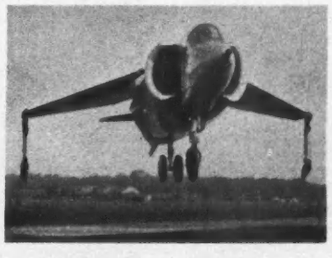
The Hawker P1127, the world's first V/STOL strike aircraft, has completed its hovering trials by flying on several occasions completely free from any ground restraint. This successful completion of the hovering tests at Dunsfold, Surrey, comes less than five weeks after its first "lift-off."

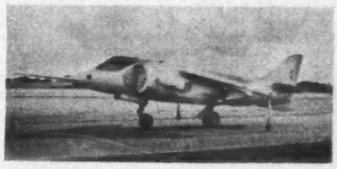
Mr. "Bill" Bedford, Hawker's chief test pilot, said, "The P1127 handles beautifully, if the hovering trials are any indication of its future success then Hawkers have a real winner."

The P1127 is a good example of successful collaboration between engine and airframe engineers, for the aircraft has been developed around the Bristol Siddeley BS53 lift/thrust engine which combines both vertical thrust for hovering flight and rearward thrust for conventional forward flight.

The P1127 was conceived as a private venture and Hawkers' faith in the ultimate success of the project was justified when, in May this year, the company received a Ministry of Aviation development contract for a number of prototypes.

The dimensions of the aircraft are: 41 ft 2 in long, 10 ft 3 in high; with a wing span of 24 ft 4 in.





The world's first V/STOL strike aircraft recently made its first successful untethered flight, powered by a Bristol Siddeley BS53 lift/thrust engine.

Importance of Microwave Techniques

Microwaves, well known for their applications to communications, will become an increasingly important tool for many areas of scientific research, according to a report recently given by a German electronics research engineer.

H. H. Klinger, who is a member of the research staff of Battelle Memorial Institute laboratories in Frankfurt, Germany, states that microwaves—the portion of the electromagnetic spectrum between radio waves and light—are of interest to scientists in many fields.

"The astrophysicist and astronomer measure the microwave radiation coming from the sun, stars, and clouds of gas in space. The biophysicist can achieve better understanding of living matter by studying the behaviour of biological tissues and bacteria in a microwave radiation field. The nuclear physicist wishes to harness microwaves to accelerate electrons and protons for bombarding nuclei and to study and control nuclear reaction."

In his recent report, Herr Klinger describes the various techniques used to produce and amplify microwaves. He also reviews microwave spectroscopy stating that "it is today one of the most important tools for studying matter in solid and gaseous states. Microwave spectroscopy can be used for accurate non-destructive analyses of biological systems, chemicals, semiconductors, and metallic ions. Further applications include polymerisation, radiation damage and photosynthesis."

According to Klinger, there is also a great deal of interest in the interaction between microwaves and a gas-discharge plasma because: "The study of microwaves penetrating through an ionised gas permits the determination of the electron density, temperature, and drift velocity of the plasma, as well as the dielectric magnetic properties of ionised gases." Microwaves are used in this way to gather data about the ionosphere and outer space and to determine the properties of the plasma in controlled-fusion research.

The important part which microwaves have begun to play in physics is due to the extreme accuracy of measurements made with microwaves. It is possible that microwave radiation could be used continuously to measure the distance to a satellite to determine an accurate orbit for both the earth and the satellite. In addition, artificial satellites orbiting the various planets of the solar system could provide more accurate measurements of the solar system.

Extremely accurate microwave atomic clocks also make possible, for the first time, experimental investigation of fundamental problems related to gravity and relativity.

Versatile Direct-View Storage Tube

A new direct-view storage tube, available from the Westinghouse Electric Corporation in the USA as tube type WL-7268, incorporates two writing guns and a viewing gun system producing a bright, non-flickering, uniform display over a 4 in diameter viewing area. Two electrostatically focused and deflected writing guns permit simultaneous writing of two independent signals.

The WL-7268 is said to be particularly useful for such applications as airborne fire control radar, weather radar, transient phenomena studies, data transmission including half-tone storage, telemetering, facsimile, and visual displays requiring steady, narrow-bandwidth transmission over telephone lines.

Performance characteristics of the tube include brightness up to 2,500 foot-lamberts with 10,000V applied to the phosphor, good resolution of half-tone displays, and good display uniformity. The writing speed of 36,000 in per second is sufficient to "freeze" high frequency transients, and storage time is long enough for examining and recording the display.

Designed to operate in military environments, the WL-7268 can be operated upressurised at high altitudes.

The base is "potted" to eliminate internal leakage and the entire tube is "potted" within its magnetic shield with a synthetic silicone-rubber material to provide protection against mechanical shock, vibration, humidity, and leakage between bulb terminals. The magnetic shield is resistant to salt spray.

An All-Electronic Telephone Exchange

The bulk of the operations carried out in present-day automatic telephone exchanges rely upon electro-mechanical components. Efficient and fast as these systems are, they have now been outmoded by a new all-electronic technique.

A CUSTOMER trial of the world's first electronic telephone central office (exhange) has been set up at Morris, a small town 75 miles from Chicago, Illinois, USA.

Developed by Bell Telephone Laboratories, it is the first system to go into operation performing electronically all the functions involved in the handling of telephone calls. It was described by the president of Bell Laboratories as " a totally new system, making possible a variety of new services which will double the flexibility and hence the value of each subscriber's telephone."

Through the use of small gas-filled valves, a vast memory system, and thousands of transistors and other solid-state devices, which operate in millionths of a second, the electronic central office (ECO) will permit the trial users to:

(1) Use home extension telephones as intercommunication systems by simply dialling two digits.
(2) Reach frequently-called numbers by dialling two digits instead of six or seven.
(3) Have incoming calls routed to another telephone when the originally-called line is engaged.
(4) Dial a code which causes all subsequent incoming calls to be automatically transferred to another number.

Other new services expected to be introduced at a later stage in the trial will permit many of the subscribers to:

(5) Allow a third party to be called into an existing telephone conversation.
(6) Have immediate connection to an engaged line as soon as it is available.

Information gained on the Morris trial will not only put the ECO system to the acid test, but it will also give an insight into the service features for which typical subscribers have a preference.

In appearance ECO has little in common with present-day exchanges. The long, high racks of equipment and the noisy chatter of relays have been eliminated. Instead there are several rows of neat metal cabinets filled with thousands of plug-in packages of electronic components. The switching network, made up of 23,000 tiny neon-filled valves, goes about its work quietly, with only a bright red glow to show which tubes are actually in operation.

STORED PROGRAMME CONTROL

One of the keys to the success of ECO is that it uses " stored programme control," that is to say, that each action of the machine is determined by instructions stored in its memory.

The difference between ECO's stored programme control and the present type of system can be simply illustrated by the different ways in which a square root problem can be solved. One way is to use a series of logical arithmetical steps to arrive at an answer to any degree of accuracy required, the other way is to look up the answer in a book of square root tables.

Existing exchanges could be said to be analogous to the first technique when working out the detailed logic of each telephone call. ECO, on the other hand, solves many of its problems by " looking the answer up in a book." In this case the " book " is information—2·25 million items—stored on photographic plates in the machine's memory store.

ECO performs its work with such speed that it has enough spare time to continually check its own circuits. When it discovers a fault, it locates and diagnoses the trouble and, in some cases, even makes the necessary corrections. If the fault cannot be corrected by the machine, it writes out in detail on a teletypewriter what the trouble is, adding the month, day, hour, and minute of the malfunction. Then the repairs can be carried out by a member of ECO's engineering staff.

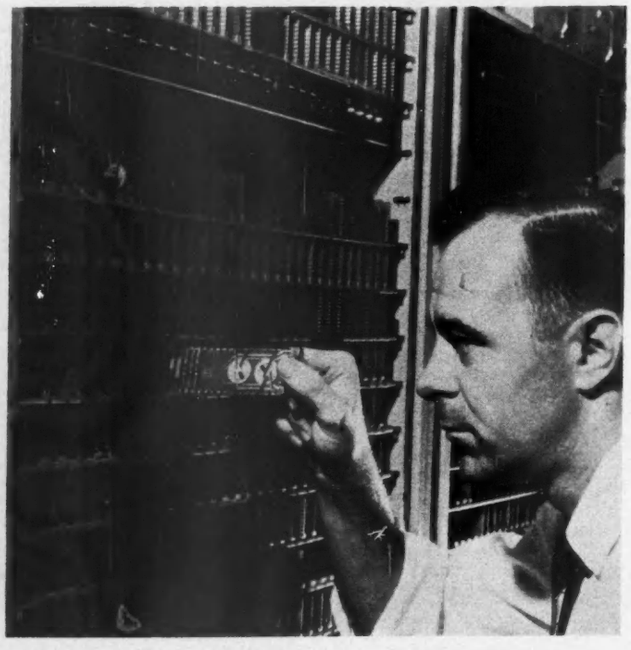
Although some of its basic theory has been known for many years, ECO became feasible only with the invention of the transistor and other semiconductor devices, and with the development of high speed, high capacity memory systems. To illustrate the importance of semi-conductors to the system it has only to be noted that the Morris ECO uses some 12,000 transistors and 105,000 crystal diodides. It uses other electronic components by the tens of thousands.

The ECO machine works on the following lines: an electron beam scanner checks the condition of every telephone line ten times per second, by day and night. When a subscriber picks up his receiver to make a call, the scanner detects the action and reports it to the " common control unit." Then a barrier-grid store indicates that this is a new call, by having recorded the fact that the receiver was in the on-hook position a tenth of a second ago. The barrier-grid store also reports that it has no record of anyone trying to reach this line, so that control unit " decides " that the subscriber is about to dial.

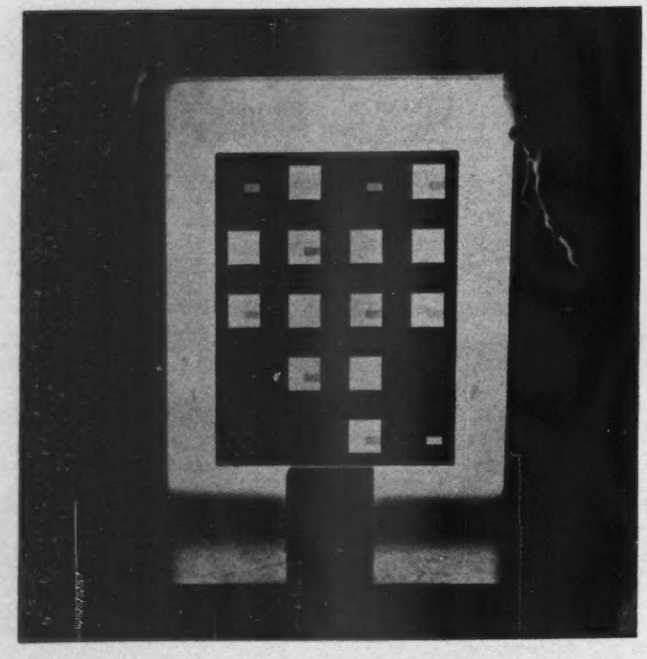
The ECO machine sends a dialling tone to the subscriber, letting him know that the system is functioning. At the same time, space is reserved in the barrier grid store for the digits about to be dialled. The scanner then speeds up to a rate of 100 sweeps per seond so that it cannot miss any of the dialling pulses.

Subscribers can be offered an additional service known as " abbreviated dialling," which will allow them to reach a selected few of the more frequently-used numbers by dialling just two digits instead of six or seven. When requesting this service the subscriber merely informs the telephone company of these numbers so that they can be listed in ECO's photographic memory store for two-digit dialling.

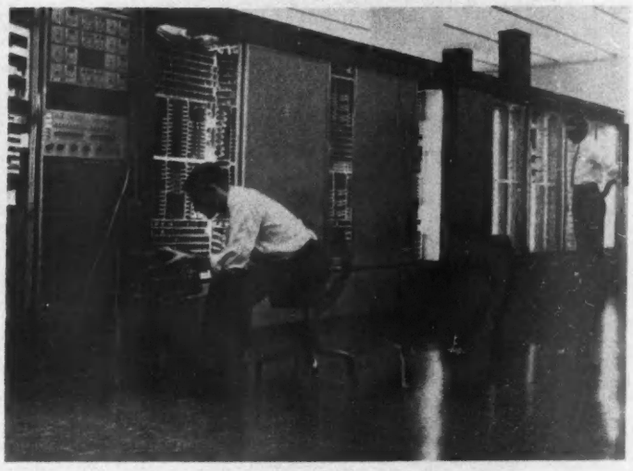
Early types of dialling telephone systems had distributed memory and logic—in the relays that were used to connect subscribers. In later dial systems memory and logic were provided more efficiently in that separate relay units were



(Right) Extensive use has been made of printed circuits, containing transistors, semiconductor diodes and other electronic components.



(Left) Items of information for the system's " memory " are printed on a photographic plate. Each of these small plates can contain 33,000 items of information, and can be readily changed whenever required.



(Left) A special type of cathode ray tube is used to scan the system's photographic memory store, which contains over two million items of information.

(Right) The switching circuit of the electronic telephone exchange is made up of 23,000 miniature neon-gas tubes.

provided expressly for temporary memory functions, such as recording numbers as they are dialled,and other relays were used solely for logic operations (problem solving).

It is the philosophy of the ECO system not simply to substitute electronic devices for relays, but rather to solve call-handling problems on a completely new basis. The solutions to these problems are found in answers stored in the photographic memory. These answers are found a thousand times faster than with older systems, and can be easily changed to meet any variation in needs.

In the search for a memory system having a vast capacity and almost instantaneous access to stored items, Bell research engineers seized on the idea of storing information on photographic plates. A cathode ray tube, somewhat similar to a television picture tube, produces a small spot of light which can be positioned to read out stored information from the plate. For each position of the spot of light, 67 different items of information can be read out.

In the flying spot store, 2·25 million items of information are stored and any item can be read in a few millionths of a second. The ECO barrier-grid tube is fundamentally a cathode ray tube but, instead of having a phosphor screen, it has a flat mica target. A beam of electrons is shot at the mica target, and where the beam strikes an electrical charge appears. A charge, or lack of charge, in any particular point on the mica represents an item of information. The item can be read quickly and then erased, leaving the space ready for new information.

The aim of this complex electronic " brain " is to direct the closing switches to connect one telephone with another. The switches in use in the ECO trial are neon tubes. When a connection is made, the tubes strike an arc in the gas, showing the typical red glow of neon. Light from blue fluorescent lamps is shone on to the tubes to facilitate quicker striking by keeping the gas molecules in an excited state. The neon tubes are also temperature controlled to maintain a high reliability factor.

Temporary changes in the telephone service are put into effect by entries made via a teletypewriter into the administration centre of ECO. When an order has been given to ECO, the machine then makes an acknowledgement through another teletypewriter, before incorporating the message in its memory store.

Intensive work on the Morris system began at the Whippany, NJ, location of Bell Laboratories, in 1954. Research on earlier versions of electronic switching systems, however, was started by Bell Laboratories as far back as the 1930's.

Although the Morris ECO is an experimental version, engineers are already at work on a production model, suitable for volume manufacture. Many components in the production model will differ from those used at Morris, but the overall philosophy of the two systems will be similar. The first production model is expected to be operating by mid 1965, and from that time on ECO will gradually be introduced into the US Bell Telephone System to meet the needs of telephone growth and to replace out of date central offices.

Near Supersonic Flight for New Jet Airliner

The Convair Division of General Dynamics Corporation in the USA has announced the completion of a new jet airliner that is certified to fly at Mach 0·91, with a cruising speed of 640 m.p.h. Known as the Convair 990, the aircraft will have a maximum range of 4,300 miles.

The 990 embodies several innovations which combine to give it high speed, stability and short operating field lengths, with a relatively high payload capacity. It is powered by four General Electric aft fan engines which have been developed from the engines which power Convair's supersonic B-58 bomber.

The power unit incorporates a turbine and fan combined in a single stage or wheel behind the basic jet engine. The inner circle of the wheel is composed of turbine blades turned by the jet exhaust. Near the circumference of this wheel, the turbines become fanblades which pull air around the basic engine and exhaust it through a double jet nozzle at low velocity, giving up to 40 per cent improved engine efficiency. The standard day thrust at sea level is 16,000 lb for each engine.

The engine is housed in a pod almost 6 ft in diameter. This is necessary because large by-pass air ducts almost surround the basic power plant and lead to the turbofan. Mixing the aft fan exhaust with the basic jet engine exhaust achieves a sound level comparable with that obtained with a sound compressor on a normal jet.

Thrust reversers are incorporated, consisting of two steel clam-shell doors which form the aft portion of the external pod surfaces when in the stowed position for flight.

On the wing's upper surface there are four streamlined speed capsules. They are pointed at each end, range from 21 to 24 ft in length, and are up to 2 ft in width at the greatest diameter.

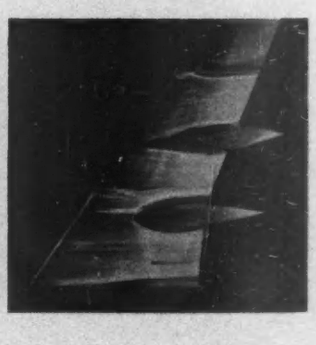
The wing with its speed capsules is designed to take a continuous supersonic airflow over the curved upper surface and at the same time to prevent formation of massive shock waves and drag. In effect, the four speed capsules efficiently reduce the intensity of the shock wave and its resultant drag by controlling the airflow over the aft portion of the wing.

Thousands of hours of wind-tunnel development work with scores of aerodynamic models were used in finalising the 990 design. This required extensive development laboratory work using both low and high speed wind tunnels.

Engineering testing began in the early development stages with exhaustive work using relatively small panels of fuselage and wing skin for strength and fatigue research. Successively larger sections of fuselage and wing were constructed at an experimental factory for proving systems, acoustic properties, air conditioning and pressurisation.

As development progressed, the test programme kept pace by taking factory items to the laboratory to acquire data for comparison with earlier research. An entire fuselage was then immersed in a huge tank and subjected to 62,000 cycles of pressure and simulated flight and ground stresses.

This test represented more than 20 years of airline operation in terms of the fatigue effects that were imposed on the fuselage.



The new Convair 990 jet airliner flies at Mach 0·91, so that airflow over the wing is supersonic. Without speed capsules (left) a shock wave is formed. With speed capsules fitted to the model (right), the shock wave is markedly reduced.

On the Shelf

By Frank H. Smith

I HAVE no means of knowing how many others are in the same position as I am, in that I both check in and catalogue (and by catalogue I mean the physical business as well as the categorising) newly published and review copies. If there are others they must bless, with me, the house of Springer. With a review copy they send the usual accompanying chit but with the difference that all the bibliographical details you need for cataloguing are on it. Pages (roman and arabic), illustrations, figures, size, price—the lot.

Here is an item for which I had better give fullest details to save letters, 'phones, postcards and telegrams to ENGINEERING. From the Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia, comes a pamphlet "The Information Problem," by Laurence W. Ross. It is their Reprint No. 146, but it may be quicker to borrow somebody's copy of *Chemical Engineering* of 21 March, from which it is taken. The subtitle is "Will an overabundance of information eventually smother your ability to use it profitably? Here's how to get through the wall of words."

They do things differently in France. I recently found that a Larousse book which I had bought in 1954 was faulty in its pagination so I shipped it back to them pointing out the errors. In a month the book came back—the same book, complete with bookplate and my notations on the title-page. Damned fools, I thought; they've done nothing to it. But believe it or not, they had broken it down and re-sewn it correctly! What makes it the more surprising is that it was a paper-bound effort. One usually finds that a publisher will take another copy from stock and send it as a replacement rather than go to all this bother but, as I say, they do things differently in France.

The Central Office of Information (Government Building, Bromyard Avenue, Acton, London, W3) have several new films available for hire dealing with such items as dust elimination in the foundry, the Hovercraft, electricity, lead (the metal, in case you have pronounced it with a long e), nucleonics in quality control, and so on. They will let you have particulars of charges, reel-length, etc.

A wide field is covered, judging by the list they have sent me, by Deighton Bell and Company Limited, 13 Trinity Street, Cambridge. It is only a typescript list but gives a quite interesting selection of new and forthcoming books on technology and the sciences.

From *Soviet News* I cull the prospect of a monthly abstract journal in 1961 on transport. 2,000 journals will be used and the body putting the abstracts out is the USSR Institute of Scientific and Technical Information.

Cambridge University Press (200 Euston Road, London, NW1) do a nice little foolscap-envelope-size booklet listing their theoretical and experimental physics book. The contents of the works are given in each case.

A large bundle of printed matter from Micro Methods Limited (East Ardsley, Wakefield, Yorkshire) deals with the New V.C. Personal Reader, the New V.C. Executive Reader (what snob value that word executive has these days), a four-point plan to deal with publishers' and librarians' problems (micro methods of course) and encouragement to spend money on the unclassified reports of the UKAEA. There is also a copy of *Micronews* No. 1 for Spring, 1960, which indicates either that this stuff has been in my drawer longer than I thought or that the firm is a bit late with its seasons. The V.C. Personal Reader appeals to me—quote: "The reader can be quickly stripped down . . . and packed away . . . in a brief case with your pyjamas or lunch." Now I know what to do with the people who use my library, although the first part may involve a bit of a struggle.

Determinate and Indeterminate

Design of Modern Steel Structures. By LINTON E. GRINTER. 2nd edition. *The MacMillan Company, New York and London.* (45*s* 6*d*)

Structural Mechanics. By SAMUEL T. CARPENTER. *Wiley, New York and London.* (76*s*)

Both these books are "old-fashioned," despite the fact that the first is newly written, while the second is a new edition of a book which first appeared 20 years ago. There the similarity ends. The older book deals with the actual design of steel structures, and is a companion volume to Professor Grinter's *Theory of Modern Steel Structures*. The book, despite the fact that even the new edition is dated, is alive, and is informed throughout with the author's deep knowledge and wide experience.

After dealing with detailing problems of riveted and welded connections, Professor Grinter discusses the behaviour of individual members, relating each topic to a number of different American design codes (which differ slightly, of course, from English specifications). Extensive and fully worked design examples are then given of roof systems, of a highway bridge, of office buildings, and of a tall building (of 16 floors). In all these practical problems theory is kept to a minimum, in the sense that virtually all calculations are made on statically determinate elements of the structure, very much in the way that they would be made in a conventional design office. Moment distribution is used, however, for determining bending moments in the rigid all-welded designs. The book ends with a brief but clear account of plastic design methods for simple beams and frames.

There is no mention of plastic methods in Professor Carpenter's book. No doubt the reviewer's feeling that this omission automatically makes the book suspect will be discounted by the less committed reader. In fact, the book presents almost every major technique of elastic structural analysis, from moment distribution to elastic centre and column analogy; as such, it is a good and convenient work of reference. The methods are displayed, however, without a unifying and connecting pattern of understanding of theory of structures.

The book deals with indeterminate structures: "A statically indeterminate structure is classified in general by determining how indeterminate it is, by establishing the degree of indeterminacy." This is a slightly unfair quotation lifted out of context, but is a fair sample of the style of Professor Carpenter. Theory of Structures is made to appear formidable, whereas it is in reality one of the simplest of the engineering disciplines. Only two equations, those of equilibrium and compatibility, can ever be written, and then connected by the stress-strain law; from such a basic approach a discussion of plastic behaviour is almost inevitable. Without that approach, it is not surprising that the book is confined to elastic topics.

One valuable chapter of the book deals with structural dynamics; a discussion of vibrations does not normally appear in a book of this type, although the analysis is straightforward. An omission is any reference to solution of structural problems by computers or to the use of models, and only passing mention is made of matrices and of virtual work.

JACQUES HEYMAN

Rationalising Nuclear Insurance

Indemnification of Atomic Energy. Activities and Operations of Advisory Committee on Reactor Safeguards: Report to the Joint Committee on Atomic Energy on Operations, 1959-60. Five parts. *United States Atomic Energy Commission, Washington 25, DC.*

Gaps in the provision of insurance cover for nuclear hazards are slowly being filled, and in America the work of rationalisation has continued during the past year. The United States Atomic Energy Commission have issued their second report (covering the period 1 April, 1959, to 31 March, 1960) to the Joint Committee on Atomic Energy on Operations under Section 170 of the Atomic Energy Act of 1954 as amended. This is the section commonly referred to as the Price-Anderson Act. As before, the report is in five parts.

The first part deals with the indemnification of licensees. The previous report (reviewed in ENGINEERING, vol. 189, p. 458, 1960) exposed a number of potential gaps between the private insurance cover which licensees are required to have and the indemnity protection afforded by the Commission under the Price-Anderson Act. Some of these gaps have been the subject of consultation between the Commission, representatives of the reactor industry and the US insurance pools. This has led to revisions in the standard policies for nuclear third-party insurance offered by the pools, which close the gap relating to accidents arising in the course of transport of nuclear materials from non-Government sources, extend the minimum notice of suspension of the policy from a bare twelve hours to something more than a clear day, and increase the limit of liability for a "common occurrence," in other words, a nuclear incident involving two or more reactor locations.

Other gaps have been filled by amendments to the indemnity regulations put into effect by the Commission during the past year or published as proposed rules. The Commis ion have agreed to fill, to the extent of $1 million, the gap which might result from the fact that the two current policies offered by Nelia and Maelu (which sobriquets stand for Nuclear Energy Liability Insurance Association and Mutual Atomic Energy Liability Underwriters respectively) do not provide for automatic reinstatement of the full amount of the cover every time a payment is made under the policy. As a *quid pro quo* the Commission may require the licensee to furnish financial protection in another form if he is unable to obtain reinstatement of the full amount within 90 days after any payment under the policy.

It is interesting to learn that the view is now accepted (contrary to that expressed earlier) that special legislation is not necessary to enable the Commission to act in this way. Legislation has, however, been requested to amend the Price-Anderson Act to exclude the Commission's liability to indemnify against damage to any "on site" property. Commercial insurance is available to cover this risk up to $60 million, so that the Commission's risk would not seem to be substantial; but it would have looked odd—and indeed contrary to the intention of Congress—if claims in respect of damage to the nuclear facility itself had diminished the Commission's $500 million indemnity.

The report reveals that by the end of February, 1960, 44 reactor licensees were covered by Commission indemnity, including 16 private organisations, of which 14 are insured and two are providing financial cover from their own resources. Twenty-three non-profit educational institutions and five Federal agencies are covered by Commission indemnity but are exempt from financial protection requirements (although some of the former have not availed themselves of this exemption and have taken out private insurance cover). Happily no claims have so far been made under any of the policies issued.

Part two of the report deals with indemnifica-

tion of the Commission's contractors. Statutory indemnity agreements have been executed by the Commission as to 43 contracts, covering all the major AEC installations operated by AEC contractors who are eligible under Commission policy for indemnity contracts. To date no claims have been filed. The insurance industry has made its claims-adjusting service available to both the licensees and the contractors of the of the Commission.

Part three concerns maritime indemnity problems. Reference is made to negotiations for an agreement with the United Kingdom on the conditions under which the nuclear ship Savannah would operate in UK ports and territorial waters. Here the real clash is between the concept of absolute liability, which has been adopted in British legislation and which not unnaturally one hopes would apply in the event (however unlikely that may be) of radioactive damage occurring during Savannah's visit, and the American indemnity against " public liability claims," which presupposes some proof or assumption of negligence on somebody's part. It will be interesting to see the final solution of this problem.

Maritime insurance underwriters are ready to offer cover up to $14 million (equal to the £5 million fixed cover required for land based reactors in the UK) for hull and collision risk, nuclear cargoes, conventional cargoes on or damaged by nuclear ships and for third party liability of nuclear ships; but one American underwriter is quoted as saying that this limit would be " entirely too low."

Part four of the report deals with the problems of foreign indemnity and contains an interesting summary of the various international conventions which are in progress on the subject of third party liability for land based reactors.

There is a reference to the recent German legislation which provides for strict liability but (like the Price-Anderson Act) does not channel liability. The amount of insurance or other financial protection which is required depends on the particular installation. The West German Government will indemnify against third party claims up to a maximum of DM500 million (£56 million) less the amount of private insurance coverage.

Part four concludes by outlining the active role which the Commission has played in urging the necessity for providing substantial governmental indemnification above what it describes as " the modest levels of maximum liability being established in the several conventions."

Part five describes the activities of the Advisory Committee on Reactor Safeguards during the year covered by the report. The constitution of this Committee is to be found in section 29 of the 1954 Act (which was part of the Price-Anderson Act) and its function is set out in section 182(*b*). Short particulars are given of the Committee's review of the safety aspects of some 21 unclassified projects, many of which were mentioned at earlier stages of their construction in the previous report.

C. J. HIGHTON

Tempting the Imagination

The Young Engineer. By CHARLES B. BROSCHART. *Phoenix House.* (12*s* 6*d*)

Taking sledge hammers to chestnuts can be both a humourless and energy-wasting gesture. Nevertheless, this book prompts such an exercise. It has been written for boys who have a bump of mechanical (and electrical) curiosity. As the publisher's note says, it answers questions, specific questions, such as what makes an aeroplane stay up? or how does a telephone work? There are 21 such questions and they are clearly answered with the aid of some useful diagrams. There is also a short but adequate index. The book (incidentally anglicised from an original American version) has modest aims and achieves them. It would make a good Christmas present for the young teenager.

But it evokes wider thoughts, which come from a very short perfunctory chapter at the end called " Engineering as a Career." The book is in a sense an introduction to engineering by way of gadgetry though the content of the book is none the worse for that, within the limits it has set itself. Nevertheless it prompts the thought that the intuitive ability of James Watt was not based upon the capacity and training of a plumber's mate. There is a world of difference between the curiosity which is roused to know *why* things work compared with *how* they work. The intellect which was fascinated only by Rutherford's apparatus would never have inferred the neutron.

Engineering as a discipline today needs men of broad outlook, who can look beyond the fascination of apparatus towards the intellectual frontiers, whose imaginations can be caught early as to the possibilities of engineering as a discipline. It has to compete for young minds with physics and chemistry.

The book which will arouse the interest of young minds in this aspect of engineering has still to be written. It is a book to be aimed at a slightly older group than the audience to which this book is likely to appeal. *The Young Engineer* could rouse the interest of enough youngsters to provide a good crop of National Certificate material and do an excellent job. But the future of engineering as a discipline and a profession demands a more profound and sophisticated approach.

G. E. TEWSON

Users Join the Supercold Club

Progress in Cryogenics. Volume 2. Edited by K. MENDELSSOHN. *Heywood.* (63*s*)

Thirty years ago low-temperature physics consisted of a small well defined group of subjects—superconductivity, liquid helium, certain magnetic properties of crystals—which engaged the attention of research scientists in perhaps a dozen university laboratories in the Old World, and two or three in the New. Those scientists regarded themselves as members of a rather exclusive club, and held occasional international conferences devoted entirely to their own pet subjects. Now that the importance of low temperatures as a tool in nearly every branch of physics is universally recognised, and facilities for their attainment have sprung up in most research laboratories worthy of the name, the situation is markedly different. Low-temperature physics as such has ceased to have any coherent meaning, and the persistence of the aforementioned international conferences, swollen as they have become with contributions ranging over the whole gamut of physics research, is an archaic anomaly of little value except as the guardian of an outworn tradition.

A good case can, however, be made out for the publication of review articles on the cryogenic techniques in general use for the attainment of very low temperatures, and that is the ostensible purpose of this series of volumes. The difficulty is that these techniques, although finding applications in an extraordinarily wide range of research, are themselves a comparatively compact subject, so that there is a strong temptation for the editor of the series to broaden its scope to include the experimental physics involved as well. This spreading is what has actually happened, and both volumes include articles in which the approach to the subject, while of the greatest interest to specialists, is quite inappropriate in a publication of this kind. Thus the second volume devotes a sixty-page article to the three-level solid-state maser, the author of which evidently himself feels that some sort of apology is called for, as it does seem rather a heavyweight in its present context. Similarly the contribution on methods of nuclear orientation has little to say about cryogenic techniques themselves, and, plunging as it does straight away into a discussion of the relevant terms in the spin Hamiltonian, assumes a level of theoretical knowledge of an unnecessarily specialised nature.

The contents of this volume are as follows (authors' names in parentheses): The Storage and Handling of Cryogenic Liquids (G. R. Zenner), The Gas Refrigerating Machine and its Position in Cryogenic Technique (J. W. L. Köhler), The Separation of Deuterium on an Industrial Scale by Low Temperature Distillation (M. P. Malkov, A. G. Zel'dovich, A. B. Fradkov and I. B. Danilov), Low Temperature Bubble Chambers (N. C. Barford), The 1958 Scale of Temperatures for the Liquid Helium-4 Region (H. van Dijk), Resistance Thermometers for Low Temperatures (C. R. Barber), The Three Level Solid State Maser (E. O. Schulz-du Bois), Methods of Nuclear Orientation (E. Ambler).

The title of G. R. Zenner's article is a misnomer. It would be better named " The Storage and Handling of Liquid Oxygen and Nitrogen, with a short Appendix on Liquid Methane, Fluorine, Hydrogen and Helium." There is, for example, only one page on liquid helium techniques. Furthermore the impression is given that practically all developments in the subject have taken place in the United States, and mainly at the Linde Company! Of 51 references in the bibliography only 6 are from outside the USA. This distribution gives a rather unbalanced appearance to the article, which is, however, of interest in giving an idea of the scale of some cryogenic installations in America.

The development of the Stirling thermodynamic cycle by the Philips' Company as a gas refrigerating machine is described in a well balanced article by J. W. L. Köhler. The principle of the ideal cycle is clearly outlined, and the deviations from it of the actual cycle described. The importance of the regenerator as an almost perfectly efficient heat store is emphasised, and the distinction between this form of heat " exchange " (in time) and the conventional counter-flow heat exchanger of the Claude cycle is brought out. The article concludes with a realistic discussion of the possible applications of the machine, and a section devoted to a comparison of its efficiency with that of other low-temperature refrigerating engines.

The Russian article on the separation of deuterium by fractional distillation of liquid hydrogen is a straightforward account of the development of the process by way of two small pilot models to a plant on an industrial scale handling 4,000 cu. m of gas per hour, and yielding a product containing 7 to 9 per cent HD from raw material containing 0·03 per cent HD. It is surprising to find that, in spite of the low overall efficiency of the process—only 0·008 per cent—

it is already appreciably cheaper than other methods of separation.

Bubble chambers using liquid hydrogen or helium are a recent and powerful development of a tool which has long been familiar to the nuclear physicist—the cloud chamber. The tracks of fast particles are made visible by allowing them to pass through a superheated liquid, thus producing nuclei for bubble formation, instead of through a supersaturated vapour. A new possibility inherent in the method is that the liquid itself can act as a nuclear target. N. C. Barford gives a clear account in his article of the rapid developments in this subject from the construction of the first small liquid-hydrogen bubble chamber containing only 120 c.c. of liquid in 1954, up to recent large chambers of as much as 500 litres capacity. Since most liquid-hydrogen chambers operate under ambient conditions of up to 100 lb per sq. in pressure and 28° K temperature, and require optically transparent windows as much as 100 cm wide, it can be seen that the technical problems involved are formidable. They are dealt with here under the headings of track formation, temperature control, expansion systems and optical systems. A curious omission is the lack of any information about the methods used to provide a vacuum seal for the large glass windows under these stringent conditions of pressure and temperature.

Dr. van Dijk's contribution on the 1958 helium scale is for specialists only. The correction of vapour pressure curves to the absolute thermodynamic scale of temperature is a highly technical subject, and most scientists are content to be provided with an accurate table of values and leave it at that. The same remark cannot be said of practical resistance thermometers, and it is a pity that C. R. Barber treats his subject in an unnecesssarily specialised way, devoting most of his article to one type only—the platinum resistance thermometer, which in any case is not much use below about 20° K. Although conventional carbon thermometers are dealt with, no mention is made at all of the successful use of special carbon films down to temperatures as low as 0·2° K.

The article on solid-state masers has already been mentioned. It is a very thorough exposition of the subject and its chief fault lies in its assumption that the reader is already well versed in the theory of paramagnetism. In a book of this nature such an approach is a mistake—oversimplification is here preferable to unintelligibility. As a result the article is also far too long, but it will of course be of value to the specialist student of masers.

A similar criticism applies to E. Ambler's contribution on nuclear orientation methods. It is of no use in an article of this kind to quote angular distribution formulae for the emission of alpha-particles involving Racah and Clebsch-Gordan coefficients, which remain undefined in the text. Where these results cannot be described intelligibly in a qualitative way they would be better omitted. The most interesting experiment mentioned here is undoubtedly that in which Lee and Yang's prediction of the failure of parity conservation in beta-decay was verified by the author and his co-workers.

In conclusion, in spite of the presence in both these volumes of a considerable bulk of interesting new information, one remains unconvinced of the value of a publication the range of which is so wide that the individual authors must inevitably find the greatest difficulty in striking the right level of presentation.

J. M. LOCK

New Books

Relativity for Engineers and Science Teachers. By LAURENCE H. A. CARR. *Macdonald.* (12*s* 6*d*)

The author suggests that the obstacle to the more widespread understanding of the Special Theory of Relativity has been that the majority of books on the subject have been directed to mathematicians. His present book is intended for the average engineer or engineering student.

Principles of Optical Crystallography. By A. V. SHUBNIKOV. *Consultants Bureau Enterprises, 227 West 17th Street, New York 11, New York.* (89·50)

Translated from the Russian, this textbook follows the course given in the Physics Faculty of Moscow State University, and therefore omits some specialised branches and techniques which are covered by parallel courses.

A Mathematical Tool-Kit for Engineers. By H. A. WEBB and D. G. ASHWELL. 2nd Edition. *Longmans.* (15*s*)

This book, addressed to student and practising engineers, presents concise information on the following topics and techniques: differential equations, uses of the operator D, methods of evaluating integrals, calculus of variations, Bessel functions, Fourier series, contour integration, complex numbers, Macaulay methods, Laplace transform, and theory of errors. The last four topics are new to this edition.

Applied Chemistry for Engineers. By ERIC S. GYNGELL. 3rd edition. *Edward Arnold.* (28*s*)

New sections have been added on nuclear reaction and nuclear reactors, and expansions have been made of the sections dealing with gasification of solid fuels with oxygen, the production of town gas from petroleum oils, and the separation of close-cut fractions from natural and cracker gas.

Molecular Distillation. By G. BURROWS. *Oxford University Press.* (35*s*)

The satisfactory utilisation of the molecular distillation process requires the active cooperation of the chemist, the physicist and the engineer, and the present book aims at presenting each with information that relates not only to his own field but also helps him to visualise the point of view of his co-workers.

The Mechanics of Vibration. By R. E. D. BISHOP and D. C. JOHNSON. *Cambridge University Press.* (120*s*)

Rather than describe the application of the mechanics of vibration to particular engineering problems, the authors have set out to present ideas, and therefore most of the discussion is in terms of "academic" systems only, that is to say, of spring-connected rigid masses, taut strings and uniform elastic bodies.

Computer Engineering. Edited by S. A. LEBEDEV. *Pergamon Press.* (63*s*)

Translated from the Russian, this is a collection of papers on various aspects of computer design and operation, including differential analysers, ferrite cores, automatic translation dictionaries, and dynamic flip-flops.

"Subsunk": The Story of Submarine Escape. By W. O. SHELFORD. *Harrap.* (18*s*)

Captain Shelford recounts the story of escapes from submarines from that of Wilhelm Bauer and his companions in 1851 to the loss of the *Affray*, and also describes the development of modern techniques, drawing on his own very wide experience.

Faceted Classification: A Guide to Construction and Use of Special Schemes. By B. C. VICKERY. *Aslib, 3 Belgrave Square, London, SW1.* (12*s* 6*d*, *members* 10*s*)

Compiled on behalf of the Classification Research Group, this slim volume is intended to help information workers to meet the continuing demand for the construction of classification schemes for detailed arrangement and cataloguing of material in restricted but intensively cultivated fields of knowledge.

Noise Reduction. Edited by LEO L. BERANEK. *McGraw-Hill, New York and London.* (112*s* 6*d*)

A textbook developed from a series of lectures presented at summer courses at the Massachusetts Institute of Technology. Contributions on sound waves and their measurement and fundamental concepts underlying noise and its control are followed by sections on damage-risk and acceptability criteria for noise, and on the practice of noise control, including case histories.

Aeronautics and Astronautics: Proceedings of the Durand Centennial Conference held at Stanford University, August, 1959. Edited by NICHOLAS JOHN HOFF and WALTER GUIDO VINCENTI. *Pergamon Press.* (80*s*)

Celebrating the one hundredth anniversary of the birth of William Frederick Durand, whose professional career stretched from service on a wooden warship in 1880 to heading the committee concerned with the development of jet propulsion for aircraft during the second world war, the present volume is made up of 19 papers on a wide variety of subjects.

Real Variable. By JAMES M. HYSLOP. *Oliver and Boyd.* (8*s* 6*d*)

The present volume in the *University Mathematics Series* ranges over such elementary topics as bounds of sets and of functions, the theory of limits, continuity and differentiation, and the properties of the simple functions of analysis.

Boiler House Practice. By J. N. WILLIAMS. 3rd edition. *Allen and Unwin.* (70*s*)

A revised edition of a textbook for the student, the executive and the practical steam engineer. A number of technical discussions have been extended and reference made to new developments.

Introduction to Atomic Energy. By WILLIAM G. ATKINSON. *Rider, New York; Chapman and Hall, London.* (11*s*)

Originally developed for use by shipyard personnel engaged on design and construction work on the first nuclear-powered seagoing vessel, the USS Nautilus, this is an approach to atomic energy for the non-specialist.

The Reviewers

Dr. Jacques Heyman is lecturer in the Engineering Department at Cambridge University. He is an associate member and member of council of the Institution of Civil Engineers. He is author of *Plastic Design of Portal Frames* and with J. F. Baker and M. R. Horne of *The Steel Skeleton*, Volume 2.

Mr. C. J. Highton is principal legal and lands officer of the United Kingdom Atomic Energy Authority. He is a B.A.(Oxon) and a Barrister-at-Law (Inner Temple).

Mr. G. E. Tewson, M.A., is a partner in the firm O. W. Roskill Industrial Consultants.

Dr. J. M. Lock is a principal scientific officer at the at the Royal Radar Establishment of the Ministry of Aviation, where he is employed in the low-temperature laboratory. He was previously engaged in research on superconductivity at Cambridge.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Manuals

Precision Bearings. E.M.O. INSTRUMENTATION LTD., Western Road, Bracknell, Berks. "Introducing E.M.O." is a booklet describing personalities and products of the company. 15 pp. illustrated.

Instruments. FERRANTI LTD., Hollinwood, Lancs. "Contributions to the Aircraft Industry" is a 15 page booklet with illustrations and descriptions of instruments and controls made by the firm in this connection.

Belting. STEPHENS BELTING CO. LTD., Snow Hill, Birmingham 4. Eight page booklet "Its an Ill Wind that Blows Nobody any Good" illustrates the manufacture of Miraclo and Meteor belting.

Control Gear. ALLEN WEST AND CO. LTD., Brighton 7. Control gear for machine tools is pictured and described in a ten page booklet; publication 1746.

Switchgear Practice. ENGLISH ELECTRIC CO. LTD., East Lancashire Road, Liverpool 10. "British Thermal Power Station Auxiliary Switchgear Practice" is the title of a 105 page illustrated technical manual covering control of all station auxiliaries.

Workholding. JAMES NEILL & CO. (SHEFFIELD) LTD., Napier Street, Sheffield 11. "Users Handbook" is a 30 page illustrated volume describing the methods of magnetic workholding and the theory behind them.

Directory. FOOD MACHINERY ASSOCIATION, 14 Suffolk Street, London, SW1. A directory of British brewery and soft drinks equipment runs to 114 pages with illustrations of most items.

Motor Accessories. AMAL LTD., Holdford Road, Witton, Birmingham 6. Illustrations and descriptions of the works and products are given in a 12 page brochure.

Marketing

Northern Ireland's Ninepence-a-sq. ft Factories

One of the success stories of Northern Ireland is the CYRIL LORD carpet factory at Donaghadee, Co. Down, which now employs 1,300 people and covers 400,000 sq. ft.

In its latest extended form the factory was officially opened by Lord Brookeborough, the Ulster Prime Minister, who paid Mr. Lord the compliment of saying: "Without Mr. Lord there would be less prosperity in Northern Ireland and less colour in the world."

It is claimed that the Donaghadee carpet works is the largest of its type in Europe and the fourth in the world. Production began in December, 1957, and it is now claimed that enough carpet has been produced to cover a three lane motorway from Land's End to John o' Groats and back again.

Working 24 hours a day, the plant produces at least 60 miles of carpet a week. The big tufting machines produce carpet in widths of up to 18 ft at a speed of 8 ft a minute.

At the opening ceremony, Mr. Lord said: "Fibre goes in at one end of the factory and 48 hours later the carpet goes straight to the user. Every bit of machinery is British. We have not paid a penny to America for know-how and I doubt if they are as advanced as us in inventiveness. All this, with the ninepence-a-square-foot factories that the Ministry of Commerce provides, makes up 100 per cent team spirit."

Sulphuric Acid Plants for Egypt and Netherlands

SOCIÉTÉ FINANCIÈRE ET INDUSTRIELLE D'EGYPTE have placed a contract with SIMON-CARVES for a complete sulphuric acid plant to be installed at Kafr El Zayat. The plant will have a capacity of 150 tons of sulphuric acid a day from elemental sulphur.

A self-contained power-producing unit is to be built with the plant in order to feed electricity back into the works mains.

To be built alongside the SIMON-CARVES-MONSANTO acid plant at Vlaardingen, in the Netherlands, is a contact sulphuric acid plant for EERSTE NEDERLANDSCHE COOPERATIVE KUNSTMESTFABRICK.

Australian Aluminium £100 million Project

The KAISER ALUMINIUM AND CHEMICAL CORPORATION, which acquired a 50 per cent interest in JAMES BOOTH ALUMINIUM at the beginning of the year, is to take an equal part with the CONSOLIDATED ZINC CORPORATION in building up an Australian aluminium industry worth £100 million.

The joint project has an output target of about 148,000 tons of aluminium a year by mid-1966. Consolidated Zinc's previous partner in the scheme was BRITISH ALUMINIUM. The agreement between the two companies was dissolved in September.

Since that time Consolidated Zinc has owned all the stock in the company formed for the scheme—the COMMONWEALTH ALUMINIUM CORPORATION (Comalco). These shares will be transferred to a fresh company and Kaiser will take a half interest.

The venture will involve bauxite mining and an alumina plant with an output of 360,000 tons a year, at Weipa, Northern Queensland. Development of the hydro-electric resources of Manapouri-Te Annau will be needed for a new aluminium smelter near Bluff, on the southern island of New Zealand, with an annual output of 120,000 tons. The established smelter at Bell Bay, Tasmania, is to be expanded to a capacity of 28,000 tons of aluminium ingots a year.

The deputy chairman of Consolidated Zinc, Mr. A. M. Baer, believes that eventually production of around 240,000 tons of aluminium a year is possible.

Euratom Contracts and Negotiations

Once again it is being proposed that Britain should join the EURATOM organisation. Nothing is yet expected to come of the suggestion but it is worth a look at the activities of Euratom within the European Economic Community.

So far the organisation has concluded 47 contracts; 24 of them under the United States-Euratom research and development programme, 7 for the Orgel project, 6 contracts of association, 7 in relation to studies of the Scientific Data Processing research team (GRISA), 2 on behalf of the Central Nuclear Measurements Bureau and one on behalf of the Ispra research establishment.

Concerned with the contracts are 22 companies, 6 university institutes or laboratories and 3 government bodies. France and Belgium each have 13 contracts, Italy 11, West Germany 7, the Netherlands 2 and there is one contract in West Berlin.

The principal purpose of the 24 contracts under the United States-Euratom agreement is the increased efficiency of the boiling-water type reactor and progress in research on plutonium recycling. There is emphasis on research on uranium and plutonium compounds, fuel, zirconium alloys and on heat transfer. Another eight contracts are in negotiation or are about to be signed.

Further contracts on the study of steels and welding techniques are being discussed between Euratom and numerous European firms.

Two nuclear power plants are to be constructed under the US-Euratom cooperation agreement. One, on the River Garigliano, north of Naples, will have a boiling water reactor and a net power of 150 MW(e). This plant is due to go critical in 1963. The second plant will be built near Givet, in the French Ardennes, by SENA, the Franco-Belgian company. This will have a pressurised water reactor with a net power of about 230 MW(e). Construction work is to begin in the spring.

UK Car Production Down in October

Both car and vehicle production fell sharply in October. Car output declined from 131,772 in September to 90,312. Car exports were also down, from 29,795 in the month before to 24,937.

2,448 cars were exported to the United States. This compares with 6,024 in September and 23,291 back in May.

Though goods vehicle exports rose from 8,786 in September to 9,074, the total UK production fell by almost a quarter, from 44,729 to 34,412.

Massey-Ferguson Move into Italian Market

MASSEY-FERGUSON, the international agricultural machinery manufacturers, have taken an important step forward in the Italian market by buying the old-established Italian tractor firm of G. LANDINI AND FIGLI SGA. The acquisition puts Massey-Ferguson into a fully competitive position in Italy for the first time.

Before this move, tariffs and credit facilities favourable to the home produced machine had curbed the efforts of exporters.

Landini are described by Mr. A. A. Thornbrough, the Massey-Ferguson president, as having "a long and excellent reputation in the Italian farm machinery field." The company recently introduced a line of modern wheel tractors and crawler types, bringing about a substantial increase in sales. It is estimated that Landini will reach a sales level of about £4 million this year.

The company manufactures a wheel tractor, a crawler type and a diesel engine not duplicated anywhere among M-F's many divisions. This means that the company may be expected to appear much more actively in the export field than before. The Landini purchase is the second recent M-F move in the area of the European Common Market. A few days earlier their third factory in France was officially opened—a 250 tractor-a-day works at Beauvais.

All Landini tractors use diesel engines produced under licence from F. PERKINS, the Peterborough company who are now a wholly owned M-F subsidiary. The 76-year-old tractor company has its factories at Como and Fabbrico.

Economics of Vauxhall under General Motors

The British motor industry is hardly likely to enjoy the expansion over the next 35 years that it experienced from 1925 to the present but it is still interesting, with the Ford share offer debate still going on, to see the progress made by VAUXHALL MOTORS since the company was taken over by GENERAL MOTORS.

The figures have been given by Mr. G. J. Leaver, director and secretary of Vauxhall motors.

Back in 1925, the year the ownership went to General Motors, the company produced 1,388 vehicles, with 1,820 employees, and exported 95 vehicles.

By 1930 this had increased to 8,930 vehicles produced by 2,725 people and 223 vehicles exported that year. The last full year before the war, 1938, saw 60,111 vehicles produced by 8,589 employees and exports had risen to 20,271.

By 1950 exports had trebled. Total vehicle output was 87,454, with 12,569 people, and 61,471 vehicles were sent abroad. In 1959 26,251 people produced 246,085 vehicles and of those 134,912 were exported.

Since General Motors took over the company has spent £750 million in Britain on salaries, wages and buying materials. The exports of vehicles are worth £390 million.

Oil Industry Orders for AEI Motor & Control

Flameproof squirrel cage motors of widely varying powers figure prominently in a series of contracts placed with ASSOCIATED ELECTRICAL INDUSTRIES Motor and Control Gear Division for work being executed for the petroleum industry.

For the Grangemouth oil refinery on the Thames, the FLUOR ENGINEERING CONSTRUCTION COMPANY have ordered thirty AEI motors of various types between one and 650 h.p., for pump and compressor drives. This refinery is to double the output of butadiene, which is used in making synthetic rubber.

MECHANICAL CONSTRUCTION have ordered 32 flameproof squirrel cage motors between 3 and 50 h.p. for a second plant in the Grangemouth project. Higher in the power scale, the KUWAIT OIL Company has asked for seven motors of 500 to 750 h.p. They are to be used to drive reciprocating compressors for the first stage of a new plant producing liquefied petroleum gas in refrigerated form. GEORGE WIMPEY and BECHTEL INTERNATIONAL are also contractors in this scheme.

This project is associated with an agreement which BRITISH PETROLEUM have signed with BRIDGESTONE TYRES for the supply of liquid petroleum gas from Kuwait beginning next year. The liquefying process in the new plant will have similarities to that which was used for experiments in shipping natural gas in refrigerated conditions over the Atlantic in the tanker Methane Pioneer.

First Nigerian Refinery a Joint BP-Shell Venture

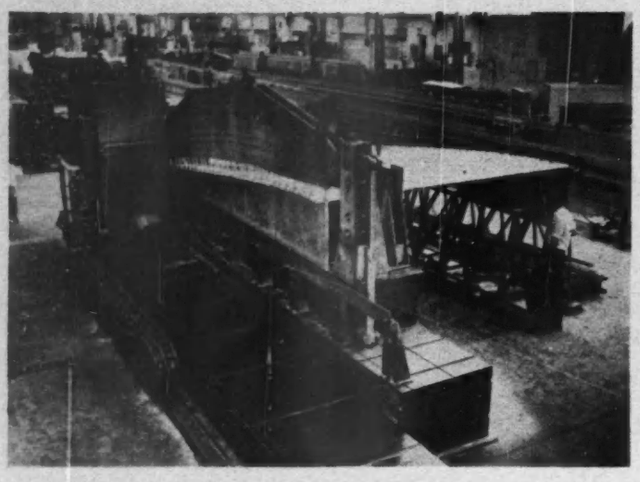
Nigeria is to have a refinery built jointly by the BRITISH PETROLEUM and SHELL companies. It is expected that the plant will be put up at Port Harcourt, Eastern Nigeria, and will have a processing capacity of about a million tons of Nigerian crude oil a year.

The first refinery in Nigeria, it will be used for processing local crude into finished products for Nigerian consumption. The refinery will be built and operated by a new company to be incorporated in Nigeria—BP-SHELL PETROLEUM REFINING COMPANY OF NIGERIA.

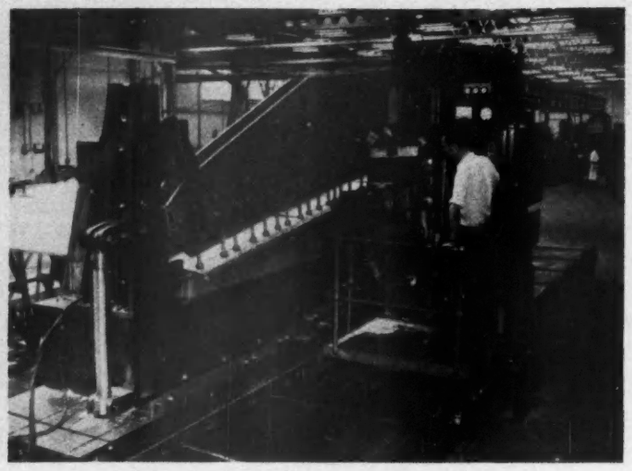
British Portable Drills Enter Russian Markets

The Russian trade delegation in the United Kingdom have placed what is believed to be the first substantial order for British portable industrial drills and equipment for use in the USSR with S. N. BRIDGES, of Battersea.

The company have previously sent small quantities of equipment to Russia but not on a major scale. This month Bridges are shipping more than 300 items from their industrial tool range. Among the consignment are 100 industrial power drills, flexible shaft machines, drill stands and small accessories.



The machine at Vickers-Armstrongs (Aircraft), Weybridge works.



The variable angle contour milling machine at work.

Contour Milling Aircraft Components

The accompanying illustrations show a variable angle contour milling machine built by the Coventry Gauge and Tool Company Limited to a design evolved by Vickers-Armstrongs (Aircraft) Limited, of Weybridge. The machine is reported to be an outstanding engineering achievement in the machining of large aircraft components to a high degree of accuracy.

The machine mills a high precision tongue along the chordwise edge of an aircraft wing section which not only follows the wing curvature but is also milled in the form of a calculated twist. This centre wing section is built into the structure of the fuselage and the machined tongue engages with the tongue on the inner end of the wing, constituting a joint capable of withstanding the high stresses set up in flight.

Basically, the machine consists of a cast iron bed in four sections extending to an overall length of 32 ft. On this is mounted a carriage which in turn carries a column, a vertical slide and a recirculating ball quadrant to give twist to the cutter head. The carriage drive is controlled by an Emotrol unit through a variable speed motor, a reduction gearbox and skewed pinion on to a straight tooth rack which gives an infinitely variable feed speed between 1 and 60 in per minute. Extending from the front are the cast iron worktable sections which are accurately machined and tenoned to the bed. The top surface of the table is also tenoned for precise location of fixtures and cam bars.

The up and down movement of the vertical slide is controlled by means of a roller follower operating on a cam bar situated at the front of the machine and mounted on the worktables. This is referred to as the contour cam bar. Roller pressure on the cam bar is controlled by means of a pneumatic cylinder and counterbalanced by weights.

The angular movement of the cutter head, to give the required twist, is controlled by primary and secondary gearboxes. These are operated from a roller follower running on a cam bar at the rear of the machine and mounted on the bed. This is called the twist cam bar. Deviations from a straight line on the twist cam bar are transferred from the follower, through rack and pinion gearing to the primary gearbox. This gearbox operates synchro and magslip transmitters, which transmit signals by electronic controls for the required movement to the secondary gearbox situated at the rear of the recirculating ball quadrant. From thence the movement is passed to the cutter head through a pinion and gear segment.

In order to obtain instantaneous response from the twist cam bar to the cutter head, it is extremely important to eliminate all backlash throughout the gear trains and recirculating ball quadrant. This called for precision machining and fitting of the highest quality, and it is interesting to note that the complete head and assembly weighing approximately 10 cwt, can be moved on the recirculating ball quadrant by finger pressure.

The contour and twist cam bars must of course be accurately positioned relative to one another. This is accomplished by tenons locating the cam bar brackets, and a dowel location between the cam bars and their respective brackets. To obtain these conditions it is necessary to machine the tenon slots in the bed and work table sections to tolerances finer than those specified in BS 969-1953 relating to length gauges.

Having fulfilled the design requirements, Coventry Gauge and Tool have produced a carriage and workhead with a 25 ft traverse, which in conjunction with contour and twist movements, enables three dimensional machining to be carried out within fine limits.

India Makes Electrical Equipment

On Sunday, 6 November, Mr. Nehru, the Prime Minister of India, took part in an inaugural ceremony at the Bhopal plant of Heavy Electricals Limited. In doing so he marked a major step in the establishment of a new industrial centre. Associated Electrical Industries Limited has been closely concerned with the Indian Government in this project which will eventually produce heavy electrical apparatus worth £40 million a year—the bulk of India's needs.

Switchgear and transformers are already being made, and before the end of the year transformers will be in production on an appreciable scale. Later, heavy fabricated parts, water turbines and their associated alternators, electric motors, and the electrical equipment for the electrification of India's railways will come into production.

Originally conceived in the late 1940's, the first positive step in the scheme was taken in November, 1955, when AEI were appointed as technical consultants and commissioned to prepare a detailed project report. After due consideration and discussion, the project report as accepted by the Central Government of wd ia in March, 1957, and work got under way. n The first step was the construction and equipment of a large training school and workshop where a sufficient number of artisans and engineers of all grades could be trained during the time taken to build the factory itself. At the present time some 3,000 men are undergoing training in the techniques of electrical apparatus manufacture.

Concurrently with the training of artisans and junior engineers in Bhopal, more experienced engineers were sent for extended training courses, some as long as three years, to the United Kingdom factories of AEI to fit them for positions as senior engineers and factory superintendents.

To make preparations for starting up production in the many departments of the factory, 97 of these men have now returned to India, while another 89 are still completing their training in the UK. A further number of senior engineers who will be required for the later phases of development at Bhopal have still to be sent to the UK over the course of the next year or two.

While this training programme has been in operation, construction of the factory itself has gone ahead rapidly. It will eventually comprise five large manufacturing buildings 800 ft long by some 600 ft wide, together with the necessary subsidiary service and office buildings.

In the first instance, work was pushed ahead with the maintenance building, which was equipped with tools to provide an engineering service for the construction work. This building was commissioned in January, 1960. Next, the switchgear and transformer shops were put in hand. The former building was substantially completed in June, and production began there on 1 July.

Machine tools, plant and manufacturing equipment are now flowing rapidly into Bhopal, some £3 million worth from the UK and much from the recently established machine tool factories in India.

The maximum size of generators and transformers planned has been increased from the original 50,000 kW to 150,000 kW in view of the latest assessment of India's needs.

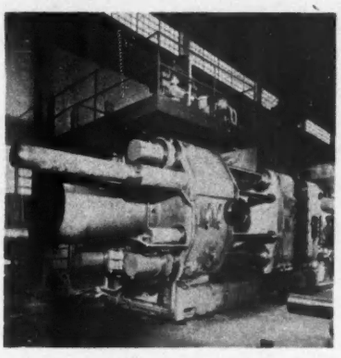
Construction work on the factory is being carried out by Indian engineers and contractors with the advice of a group of AEI engineers stationed at Bhopal. This group will later be enhanced by production engineers and demonstrators, who will help the management of Heavy Electricals to get production under way.

Large-Scale Injection Moulding

What is claimed to be the largest and most powerful injection moulding machine in the world has been produced by Triulzi of Milan. It has an injection capacity of 425 ounces and a clamping force of 2,500 US short tons.

The first three units produced have been ordered by a German firm for the production of refrigerator parts. Output is high at the rate of one part every two minutes and the unit is ideal for producing large household articles.

The machine was designed to be automatically controlled but every movement can be controlled separately by means of push buttons. The injection force can be adjusted up to a maximum of 220 tons and with a standard injection plunger it is possible to obtain up to 22,000 lb per sq. in. With this pressure and with very high injection plunger speeds it is possible to process any thermoplastic materials and obtain thin walled mouldings.



Largest injection moulding machine.

The body of the machine is of cast steel with rolled steel sections in the bedplate. The rams and tie bars are ground and hard chromium plated. Steel and various special materials have been used for the sliding parts and components under stress. The hydraulics, valves, distributors and servo-controls are located on an accessible platform fitted over the reaction head.

The electrical components, the timers, the electronic recording devices and the temperature control equipment are located in a special sealed box. All electrical equipment is separate from the machine to avoid any vibration effects.

Triulzi machines are available in this country and the Commonwealth through Baker Perkins Granbull Limited of Kingston-upon-Thames.

Making Transformers

The English Electric Company have transferred the development, manufacture and test work on transformers from 1·5 MVA to 400 MVA and above to a new works at Stafford.

The building covers an area of 245,000 sq. ft and has six parallel bays each 580 ft long; the largest of which is 85 ft wide. The works have been laid out for the specific process of producing transformers, and were designed by company engineers with the aid of the consulting engineers, Merz and McLellan. There are two main features. The first is flow line production from raw materials to final test with minimum movement of components or the completed transformer. The second is the provision of sufficient head room and lifting gear so that the very large transformers of 500 or 600 MVA envisaged for the future can be "leap frogged" down the production line by hoisting them up and moving them along by travelling cranes. The main bay is designed for two 200 ton cranes which can be used together to move up to 400 tons through a 60 ft lift.

Attention has also been given in the layout to the problem of moving large loads. With the increasing sizes of transformers, the physical dimensions of the equipment after it has been divided into components for shipment still create problems in transportation in this country and overseas. Thus a wide gangway runs between the final assembly bay and the test area, so that components can be loaded directly on to a transporter.

It is believed that the most powerful impulse generator in the world is installed in the test area. It can produce 4·8 million volts with a 346 kW sec energy rating. Complete tests, including a full load heat run, can already be made on transformers up to 600 MVA with the present plant. Extension to larger sizes is provided for in the buildings. The impulse generator was designed and built at Stafford by English Electric staff. The figure of 600 MVA is for 50 c/s operation—at 60 c/s substantially larger transformers can be tested.

Four 10 MVA d.c. motor driven alternators combined with a 42 MVAR bank of capacitors represent the bulk of the test supply equipment. Two smaller machines totalling 1,000 kVA capacity provide a variable frequency auxiliary system and a third set rated at 7·5 MVA is used for over-potential testing at frequencies between 100 and 200 c/s. One of the 10 MVA alternators may be synchronised to the incoming 11 kV supply to provide variable d.c. for reactor testing.

A versatile range of testing transformers is installed to allow the selection of any voltage between 11 kV and 80 kV in steps of approximately 1 kV, so allowing optimum use of the test plant capacity.

The major part of the test plant is installed in a separate machine hall which is air conditioned and temperature controlled. Effective separation of the rotating machinery from the outside test area becomes increasingly important when a subdued ambient noise level is necessary during transformer sound level testing.

Careful attention has been paid to the accuracy of the instrumentation, particularly for equipment used at power factors down to 0·05 which is common figure in the measurement of transformer copper losses. At this power factor, the instrumentation is accurate within ½ per cent. Current and voltage transformers associated with these instruments are permanently installed in the test bus system and have been callibrated *in situ* at the low power factors used.

Testing carried out on the shop floor is marshalled from control galleries overlooking the test area. A radio link between the various members of the team ensures that all tests are completed without unnecessary delay. Eight transformers can be tested simultaneously.

Expanding the Output of Chemicals

Many of the Tees-side plants of Imperial Chemical Industries Limited's heavy organic chemicals division at Wilton and Billingham are currently being modified to obtain substantially greater outputs with little additional capital expenditure.

Manufacturing capacity for high purity ethylene from the three olefine plants at Wilton is now being stepped up from 120,000 tons per annum to about 140,000 tons per annum. There will be corresponding increases of the other products of these plants, for example, propylene, butadiene and butenes. This means that larger supplies of feedstocks will be available for the plants at Wilton and Billingham, both of the heavy organic chemicals division and other divisions, which depend on the olefine plants.

For example, the capacity of the acetone plant is now being expanded from about 28,000 tons per annum to 36,000 tons per annum by mid-1961. Acetone is produced at Billingham from Wilton propylene which is piped under the Tees. It is used within the company for the production of methyl methacrylate, the basis of Perspex, and throughout industry as a general solvent, particularly for paints. Propylene is also converted to butanols at Billingham in part of the carbonylation plants, which are being extended to keep up with the demand for these and higher alcohols.

Following a considerable expansion in the production of phenol at Billingham, new equipment is being installed in the phenol by-products plant complex to enable the combined production of Topane and para-phenylphenol to be raised from some 650 tons per annum to 1,000 tons per annum by the end of 1961. Topane is ICI's brand of ortho-phenylphenol and an efficient disinfectant and preservative. Para-phenylphenol is an intermediate in surface coating resin production.

The two para-xylene plants at Wilton are being modified to give a further large rise in capacity. Para-xylene is one of the two major raw materials for Terylene manufacture and is also sent to several overseas countries for the production of polyester fibres.

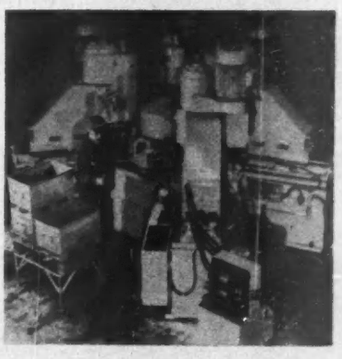
In the meantime, rapid progress is being made with the heavy organic chemicals division's new plants at Severnside, Gloucestershire, for producing 35,000 tons per annum of ethylene oxide, ethylene glycol and associated products.

Making More Mining Equipment

On 25 November, a new factory for the production of rock drilling equipment was opened in Stockholm by the Sandvik Steel Works Company Limited of Sandviken, Sweden. The main output of the new factory will be detachable bits and extension steels used in drilling holes of more than 1½ in diameter. This extension of Sandvik productive capacity has been made necessary by a continually rising world demand for their drill steels and bits; in fact, the company now claim that nearly half the rock drilling currently in progress throughout the world is being done with their equipment.

Some of the machine tools in the factory are of unusual design. An example is the machine shown in the accompanying illustration which automatically carries out eight different cutting operations during the production of detachable bits. The biggest detachable bits which will be made will be 9 in in diameter. Each of these weighs 132 lb.

Although the company has manufactured drill steels since 1859, they had to revise their production methods drastically in the early 1940's with the advent of the hard metal tip. Previously, heavy drills with low percussion rates had been the rule; but from the last war onwards they were largely superseded by light-weight drills with a high percussion rate and mounted on pneumatic pusher legs.



This machine tool completes eight different machining operations.

Steels for these drills were developed in conjunction with Atlas Copco AB, also of Stockholm. The hard metal is inserted into the tip of the drill steel; it is a sintered product consisting of approximately 90 per cent tungsten carbide and 10 per cent cobalt.

Factory Gas Supply from Butane/Air Plant

Although W. C. Holmes and Company Limited of Huddersfield have designed and installed numerous liquefied petroleum gas plants during the past few years, the recently commissioned butane/air plant at the Hereford works of Henry Wiggin and Company Limited is of particular interest as it is the largest and most comprehensive installation in this country outside the gas industry. The plant has been designed to store 500 tons of liquid butane, the equivalent of about 240,000 therms, and to supply the total gas requirements of a modern factory of 50 acres. The main reason for using this type of plant rather than taking ordinary coal gas was the difficulty in obtaining the latter in the Hereford area where Wiggins are now centralising their activities. In addition to this, the butane/air gas is a matter of pence per therm cheaper, though it will presumably take some time for this difference to pay for the plant. Wiggins are reported to be very pleased with the the gas they are getting from the plant.

In operation, butane vapour is mixed with air. This serves a dual purpose; it reduces the heat content of the vapour to a usable value and it also reduces its dew point (the temperature at which vapour condensation takes place). This lowering of the dew point eliminates the possibility of the vapour separating from the air and condensing in the distribution lines.

Liquid butane is transported from the refinery to Hereford in specially designed road tankers. To speed turnround of the tankers, a special method of liquid transfer, known as the vapour pressure method, has been adopted. Compressors draw vapour from storage vessels, compress it and pass it into the tanker. This displaces the liquid which flows from the tanker into the selected storage vessel. When the liquid stops flowing—both visible and audible warning are given of this event—the valve system of the compressor is reversed so that the remaining vapour in the tanker is transferred back to the storage vessel. This system has two main advantages: firstly, it gives a rapid discharge of the butane, and secondly, the tanker is emptied not only of liquid but also of virtually all the vapour.

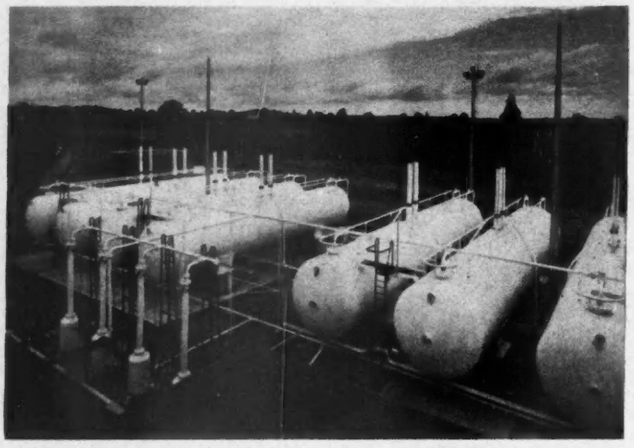
There are eight storage vessels at Hereford, each of which is 10 ft in diameter and 56½ ft long. When these vessels are filled to 86 per cent of their total capacity, the required total of 500 tons of liquid is reached. The remaining 14 per cent forms the vapour space and allows for expansion of the liquid.

Each vessel is fitted with multiple safety relief valves which are fitted on special manifolds to facilitate the removal of individual valves for inspection purposes. The number of valves is such that at all times the vessel is fully protected. A float operated liquid contents indicator shows the contents of each vessel.

Excess flow limitation valves, designed to close in the event of a sudden excess vapour flow, are fitted in the vapour off-takes. These latter valves are maintained in the appropriate position by means of hydraulic pressure which is automatically released should the pipelines suffer mechanical damage.

Each vessel is fitted with water spray manifolds which, when necessary, can supply an adequate covering of water. This acts as a protection from either abnormally high ambient temperature or radiated heat.

There are four vaporisers, each consisting of a vertical cylindrical pressure vessel containing internal heating coils which are supplied with saturated steam. Each vaporiser has been designed to produce 24,000 cu. ft per hour of butane vapour.



The butane/air plant, showing a number of the storage vessels with four of the vaporisers in the foreground.

After vaporisation, the butane is passed through suitable stages of pressure reduction to the inlets of six Holmes-Kemp carburettors where the butane, at near atmospheric pressure, is mixed with the correct amount of air. Since the butane/air mixture is required to have a preset and constant calorific value, the ratio of butane to air must be closely governed. The ratio is set manually, each carburettor being tuned to a Wobbe index recorder. When the correct setting is obtained, the hand wheel controlling the mixture is locked against interference, and the ratio of the butane to air remains constant over the whole range of output.

Plant output is controlled by a plant operator who ensures that the potential of the carburettors in operation is always higher than the factory demand as registered by the flow meter on the central control panel. Minute to minute variations of demand are absorbed by the automatic features of the carburettors.

As the plant is required to operate 24 hours a day, all electrical controls and gauges have been positioned on a central control panel to reduce personnel requirements on the various shifts. The panel contains pressure gauges for steam, butane and butane/air; tank contents gauges; flow and Wobbe number recorders; indicator lights to show high and low Wobbe numbers, and low butane and butane/air pressures.

A system of safety devices and interlocks is provided on all mixing units so that in the event of incorrect operation, failure of butane or electrical supplies, alarms first indicate the fault. Then if the fault is not corrected the plant is automatically shut down.

In designing this plant, particular attention had to be given to the safety precautions peculiar to LPG's, and steps have been taken to meet all foreseeable eventualities. The absence of specific legislation covering the installation of butane/air plants necessitated the close cooperation of the local authority and appropriate Government departments. Every help was given by all concerned—in particular by HM Chief Inspector of Factories.

Height Control for Profiling Machine

The Hancoline oxygen profiling machine, manufactured by Hancock and Company (Engineers) Limited of Croydon, has now been improved by incorporating in it an automatic height control unit. This has made operation of the machine simpler and has increased its efficiency.

The height control system consists of a small electronic control unit fitted in a sheet-metal case mounted on top of the machine. A remote hand control switch box is attached to it. This is mounted with clips so that it can be positioned anywhere along the burner bar. The box has one switch for each burner which either raises the burner to its maximum height or lowers it until it senses the height of the plate to be cut. With the switch in the "automatic" position, the burner maintains a constant height above the plate during cutting.

The burner is raised and lowered by a fractional horsepower motor connected to a lead screw in a fully enclosed mechanism attached to the vertical slide of the machine. Three electric cables run between the motor and the control box in one plastic sheath. A separate coaxial cable passes from the control box to the circular ring round the bottom of the nozzle. The capacity variation between the ring and the material beneath the burner, through the electronic control system, causes the motor to turn in one direction or the other to raise or lower the burner.

There is a small knob for fine adjustment of the burner height on top of the control box which allows manual control of nozzle height. Further adjustment can be obtained by raising or lowering the ring in relation to the nozzle itself.

When the raise/off/automatic switch is in the raise position, the burner moves to the top of its stroke and stops in that position because the switch overrides the controlling relay. In the automatic position, the burner comes downwards until it senses the plate height. It then keeps a constant height above the plate. When this position is reached, it is recommended that the main slide is adjusted so that the automatic height control is half way along its stroke. This enables the burner to move freely in both directions according to whether the plate undulates up or down.

The unit can also be used for bevelling up to 45°, either by angling the whole burner assembly, in which case the burner moves up and down in the line of cut, or by angling the burner only, when the burner moves up and down vertically. The probe ring is made so that it can be kept approximately parallel to the plate surface when the burner is used for bevelling.

Although the unit is intended for use with 220/250V single phase a.c. at 50 c/s, it can be built for 60 c/s use and for other voltages.

Distributing Power to Moving Trains

The new rail electrification scheme north-east of London operates at 6·25 and 25 kV a.c. Control of the power distribution system is carried out from a central control room at Romford. Voice-frequency telegraphy is used to operate switchgear remotely.

THE new rail electrification scheme linking London (Liverpool Street) with Enfield, Hertford, Bishop's Stortford, and Chingford, is characterised by the high frequency of service and the short distance between stops. On the Enfield Town line, for example, the average distance between stations is ¾ mile. The resultant continual starting and stopping of trains in the system causes marked fluctuations of load in the supply system feeding power to the individual trains. Consequently, much care has gone into making operation of the system flexible and reliable.

Work on the scheme began in the autumn of 1957. The route is mainly two-track, apart from Bethnal Green to Hackney Downs, where there are four tracks. Approximately 45 route miles and 111 single-track miles are involved.

The single-phase 25 kV 50 c/s a.c. system with overhead conductors is used. On account of clearance difficulties, the voltage is reduced to 6·25 kV in the built-up districts reaching as far as Cheshunt, with 25 kV in the rural areas beyond. The changeover between the two voltages is effected just south of Cheshunt station.

Power supplies for traction purposes are obtained from the National Grid, and fed into five railway feeder stations at Bethnal Green, Silver Street, Wood Street, Rye House, and Bishop's Stortford. These normally supply the tracks on either side of them to a distance about half-way to the next one. As the Central Electricity Generating Board do not guarantee the traction system to be connected between the same phases throughout the length of their distribution network, it is necessary to provide neutral sections between feeder stations. Neutral sections have been equipped with switchgear so that, when any one feeder station is out of action, through feeding can be extended to cover the tracks towards the next operative feeder station.

At Bishop's Stortford, the feed is for emergency purposes only and the feeder station there has been designed as a mid-point track-sectioning cabin with a two-section 25 kV switchboard incorporating a bus section switch—as it may ultimately be required as such for the extension of electrification to Cambridge, when another supply point would become available.

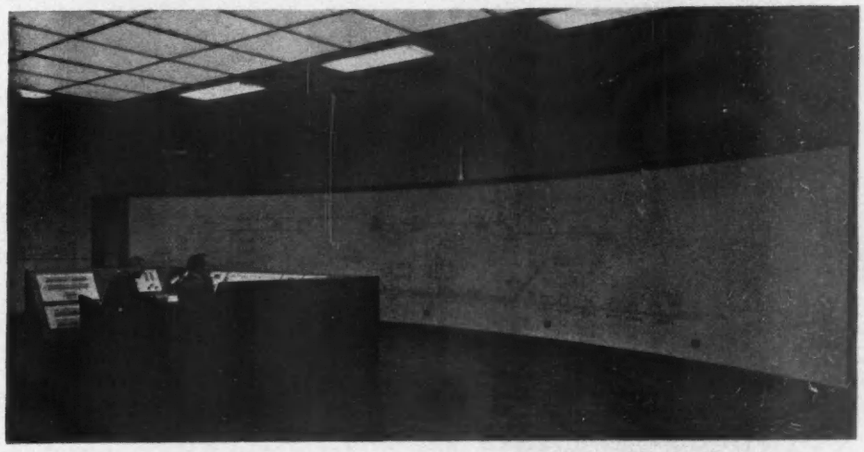
The 6·25 kV track-sectioning cabins associated with neutral sections have two-section switchboards, with normally-open bus-section switches. These are provided at Clapton, Stoke Newington, and Southbury. Track sectioning cabins with single-section 6·25 kV switchboards are provided at Liverpool Street, Hackney Downs, Bury Street Junction, Chingford and Enfield Town. At Harlow and Hertford (East) track-sectioning cabins, there are 25 kV single-section switchboards. There is a voltage change-over neutral section at Cheshunt and both 25 kV and 6·25 kV switchboards are installed in the track sectioning cabin there, together with a 3 MVA 25/6·25 kV transformer.

Outgoing track feeder circuit breakers are generally fitted with distance impedance protection, set to trip on forward current only, with thermal protection as a safeguard against persistent faults of a magnitude similar to peak traction loading. Where a circuit breaker is used to parallel two tracks it is fitted with simple overcurrent and thermal protection. Incoming track feeder circuit breakers are fitted with overcurrent protection, which forms a back-up for the distance impedance protection. An automatic reclosing feature is provided on all track-feeder circuit breakers. For 25 kV, the reclosing time interval is adjustable between 2 and 10 sec; for 6·25 kV it can be varied between 10 and 120 sec.

CONTROL CENTRE

Remote supervisory control and indication facilities for all circuit breakers and motorised overhead line switches for the lines mentioned above are provided at a new electrical control centre at Romford, Essex. The room also controls the electrified line from Liverpool Street to Southend.

In 1949, when the four tracks from Liverpool Street to Shenfield were electrified, a depot and sidings were built at Romford from which the maintenance of the overhead equipment was carried out. The new control room has been added to the original depot and has two apparatus rooms, two battery rooms, a workshop and a telephone exchange associated with it.



The control room operates remotely the switchgear associated with 13 feeder stations and 18 track-sectioning cabins.

From the control room, switchgear associated with the 13 feeder stations and 18 track sectioning cabins can be operated. Control is from a discrepancy-type diagram mounted in mosaic fashion on the control board. Operation impulses to, and information from the feeder stations and track sectioning cabins are transmitted by a voice frequency telegraph system. Transistorised equipment is used. One duplex channel is allocated to each of the outstations.

Each of the three control desks in the room has a complete telecommunications system, including certain direct lines and connections to the adjacent private branch exchange. On the desks, indication is given of such items as voltage at various supply points and half-hour maximum demand on request, transformer tap positions, and alarms.

OVERHEAD EQUIPMENT

The private branch exchange is connected to the electrification telephone system, which has instruments in all stations, overhead line switch positions, and instruments or plug-in points at approximately half-mile intervals. This exchange also has connections to the normal railway network and direct lines to the Electric Traction Engineer's central depot at Ilford, and to three maintenance depots at Pitsea, Colchester and Cheshunt.

The overhead line equipment is of simple and stitched catenary construction. It consists of a 19/0·083 stranded cadmium copper catenary from which the 0·166 sq. in solid grooved cadmium copper contact wire is suspended by droppers. The major portion of the overhead system is of the automatic tension type, tensioning being applied by weights. The line is sectioned electrically, not only at the feeder stations and track sectioning cabins, but also by switches at certain strategically placed overlap spans and neutral sections. A system of return conductors and booster transformers avoids interference with signalling and telecommunications circuits from traction currents.

At a voltage changeover point, such as the one at Cheshunt, or at any place where the supply changes—that is, where it is fed to the overhead lines from a different source—a neutral section is required. This comprises an arrangement of four gaps formed by parallel conductors or section insulators in the overhead line, so that locomotives or multiple unit trains with varying pantograph spacings will not bridge two sections of different phase or voltage.

To ensure that a pantograph does not draw an arc when passing from a live section to a dead one, a method has been devised whereby the circuit breaker of any electric locomotive or motor coach will open automatically on approaching the voltage changeover section and reclose after leaving the section. This is achieved by positioning permanent magnets on the track before and after the point of voltage change and providing each traction unit with a receiver that accepts a signal as it passes over each track magnet. The first signal, received by the unit before entering the changeover section, automatically opens the circuit breaker, power is shut off and the unit then coasts over the changeover section. The second signal allows the voltage detection equipment on the unit to set the changeover switch connected to the pantograph to the new voltage, thus reconnecting the transformer windings suitably for the new voltage. The circuit breaker is then closed and power restored. Successive traction units of a multiple unit train effect the changeover in sequence.

With the introduction of the 25 kV overhead system, it was decided that in the interests of safety all open flights of cabling serving lighting columns on station platforms should be removed. As the existing lighting installations dated from about 1928, they have been removed entirely and replaced by cold cathode fluorescent lighting. Liverpool Street, is the exception: there colour-corrected mercury vapour lighting has been mounted at a high level, to highlight the " classic lines" of the building.

Gas-Turbines in Arabia and Beckton

An account of running experience obtained with Ruston TA gas-turbines in various installations has been given by Ruston and Hornsby Limited, Lincoln. In Saudi Arabia the Arabian American Oil Company operate 11 of these 1,260 b.h.p. turbines for crude oil pumping. The reliability of the machinery and the simplicity of the building needed to house the gas-turbines enable maintenance staff to be kept to a minimum—an important consideration in remote installations.

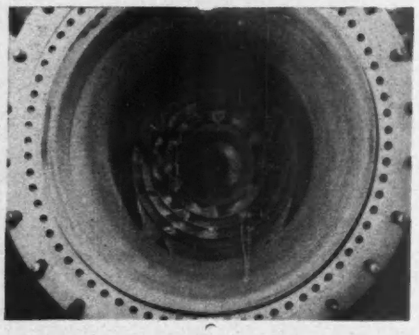
At Safaniya, the first of the Aramco crude oil pumping stations to start up TA turbines, there are five turbines running on natural gas produced in association with crude oil from the offshore Safaniya field. By 25 May, 1960 (the latest date for which records are obtainable) the first turbine to be installed had run 12,124 hours and two others had exceeded 10,000 hours. Ruston's say that this is quite normal for these machines; one, installed in a South American oil field, ran for 17,000 hours (nearly two years) before being dismantled for examination.

Four of these turbines are also installed at the Aramco pumping station at Khursaniyah. They were intended to be fuelled on crude oil from the Khursaniyah field, but at the time of their installation in November, 1958, this was not available and the turbines were tested and accepted on gas oil. They were finally commissioned to operate on crude oil in January, 1960.

At Nariya pumping station, two TA turbines fuelled on crude oil from the Trans-Arabian Pipeline system are in operation. These are approaching running times of 10,000 hours.

As various Arabian crudes contain small quantities of vanadium, an additive system is used at Khursaniyah and Nariya to inject magnesium sulphate solution into the fuel immediately before it enters the burner. The effect is to reduce blade corrosion and to ensure that the ash formed on the turbine blading is water soluble. To clean the turbine blading of the ash deposits accruing during service, water washing gear is fitted, and operated periodically.

Back at Beckton, the LCC's Northern Outfall Sewage Works in Essex, the first strip down of one of the eight Ruston TA gas-turbines which supply all the power and heat required by the sewage plant took place recently. All the turbines can operate on diesel oil or sludge gas and are designed so that a fuel changeover can be made while the turbine is on load. At the start of operations at the works, when the quantity of sludge gas was insufficient for fuel, the first turbines were commissioned on diesel oil and only changed over to sludge gas as supplies increased. Five of the turbines drive air compressors and three of them drive alternators.



After over 5,000 hours the combustion chamber of the gas-turbine was in excellent condition, in spite of the high carbon dioxide content of the sludge gas burnt in it.

The turbine selected for strip-down was one of the five coupled to air compressors, four of which are in continuous operation to provide 100,000 cu. ft of air per minute of the diffused air plant. The inspection was carried out prematurely after 5,780 hours of running at the request of LCC engineers, who wished to gain as much experience as possible with the machine before the Ruston personnel at Beckton ended their supervision.

The condition of the stripped-down components was considered to be extremely good. As was expected, considering the proximity of Europe's largest gas works, the compressor blading was slightly fouled. The illustration shows the condition of the combustion chamber, which despite the high carbon dioxide content of the sludge gas (32-38 per cent) has proved trouble-free in operation. The heat exchanger in the basement was also found to be clean.

Of the 5,780 hours of operation before inspection, 717 were run on diesel oil and the remainder on the sludge gas produced on site. Oil consumption was 61 gallons per hour and gas consumption about 16,000 cu. ft per hour. If a comparison is to be made, however, an allowance should be made in the gas consumption for the power consumed in driving the gas compressors.

Although sufficient gas to meet the whole requirements of the power house has been produced for some time, it should not be assumed that the gas is obtained without cost. Many factors must be taken into account when assessing the savings resulting from the use of sludge gas. Among the more difficult to resolve is the proportion of the plant's building and running costs but it can be definitely stated that the running costs are very much less than if the whole of the fuel supply had to be purchased.

Confidence Tests in Repeaters

The high reliability called for in underwater equipment associated with deep submerged cables means a rigorous test schedule for the equipment before it is put into use. Components for repeater amplifiers are subjected to careful quality control and life tests before being accepted. Assembly of the amplifiers takes place under ultra-clean conditions. And, finally, the complete units are tested for several months before being accepted for service.

Equipment designed for confidence testing of submerged telephone cable repeater amplifiers has recently been produced by the electrical measurement division of Elliott Brothers (London) Limited, to the specifications of Submarine Cables Limited. With this equipment, repeater gains can be monitored continuously for a period of three months.

One 7 ft rack of equipment provides facilities for testing three repeaters. Two-way repeaters can be tested in the high or low frequency band by arrangement of coaxial links. A differential monitor unit compares a test signal at the output of a repeater with a signal from the same oscillator source, arranged to be at a similar amplitude by means of attenuators. Recording decibel meters, fed from a difference signal obtained from the monitor units give a continuous record of repeater performance.

By using at least two monitors for each repeater, the possibility of false readings owing to monitor faults is greatly reduced if not eliminated completely.

Comet Leaves North Atlantic After Profitable Flying

The Comet 4 was withdrawn from the North Atlantic route on 16 October. This move was planned in 1958. The whole Comet fleet is now working the routes for which it was chosen in 1955, linking London with South America, South Africa, the Orient to Japan, and Australia.

The Comet 4 was never intended as a North Atlantic aircraft. Nevertheless, it inaugurated the first jet airliner service across the route and, alone, maintained Britain's jet operations on that route for 20 months. It was designed in the first place for trunk-route duties involving stages up to about 2,500 miles while carrying 60 to 80 passengers. This size and capability suit BOAC's South Atlantic, southern, and eastern routes, and also the requirement of other operators flying long-distance stopping services. The Comet profitably provides a frequent service in such conditions—a feature which appeals to travellers and promotes traffic growth. Also it can safely use airports of moderate size.

The North Atlantic is unique among air routes. Traffic is heavy, although a dozen or more operators compete for it. A greater frequency of service would have no particular attraction because the difference of clock time between London and New York conspire with the distance to concentrate departures into certain periods of the day. Also the length of the stage, 3,000 statute miles, and the strong westerly winds call for an airliner with a somewhat longer range than the Comet.

By reason of airframe and engine developments, however, the Comet 4 proved to have a substantially better performance than expected. And early BOAC proving flights showed that it could operate profitably on this exceptional ocean crossing. So the Comet got the job, pending the delivery of the larger Boeing 707's.

Events more than justified this decision, say de Havillands, makers of the Comet, even if it did mean some delay in deploying the full Comet fleet on the routes for which they were first intended. In the two years of operation across the North Atlantic, from 4 October, 1958, to 16 October, 1960, 2,304 Comet crossings have been made, an average of just over three each day. Over the first year—when the number of Comets rose from 2 to 14—the frequency of service increased from one flight a week to a summer peak of two services a day. During this period, 73 per cent of the London-New York flights arrived within 15 minutes of the advertised time, and 89 per cent within an hour of it. In those first 12 months there was not a single engine failure in flight. In one case an engine had to be shut down owing to trouble with a fuel-control unit.

In the two years on the Atlantic route, the Comet operated services from London to New York, Montreal, Toronto, and Boston. Some 94,000 passengers were carried and an overall passenger load factor of 74 per cent was achieved. On the eastbound services more than 92 per cent of the flights were accomplished non-stop. On westbound flights, against the strong prevailing winds, more than 100 flights were made without a stop. The reliability of the aircraft is such that an overall utilisation period of 10½ hours per aircraft per day was reached. One individual Comet made ten return trips to New York in 11 consecutive days.

Screw Conveyor Discharge for Grain Vehicle

A discharge screw conveyor has been fitted into a bulk grain hopper vehicle recently built on a 25 ft semi-trailer by H. Woodward and Son Limited, of Formby, Lancs.

Weighing only 21 cwt and built from aluminium sheet supplied by Alcan Industries Ltd, Banbury, the body can carry 12 tons of grain. It is 26 ft 8¼ in long by 7 ft 6 in wide and has a capacity of over 600 cu. ft. Although the floor of the hopper slopes at approximately 27½°, externally a rectangular appearance is maintained by extending the side of the vehicle below the floor level.

Cast underframe pedestals of Noral 117 rest on timber packing and are attached to the main chassis members and support channel-section cross-bearers. The discharge screw-conveyor runs the whole length of the trailer in a semi-circular channel set at the apex of the floor and supported from the cross-bearers. Four bearings for the screw are also supported from the cross-bearers. Power for the conveyor is supplied by a 5 h.p. electric motor through a chain drive, the motor being situated beneath the floor.

Overload prevention is given by taking the weight of the load on panels which are placed over the screw. There is a clearance of 1½ in between the panels and the floor of the hopper

Conveyor discharges 12 tons in 20 min.

and to allow inspection of the screw they are hinged.

The full 12 ton load can be discharged through a rear orifice in 20 minutes but about 2½ tons of the load can be discharged by gravity through a side outlet.

Oil-Clutch Designed for 10,000 Hour Life

Clutches used in vehicles like fork lift trucks, are generally subjected to conditions which are extremely hard and damaging. With this in view, an oil clutch capable of giving 10,000 hours of service has been fitted as a standard item on fork lift trucks in the 15,000 to 20,000 lb capacity range made by Hyster Company, International Division, PO Box 328, Peoria, Illinois, USA.

The makers claim that the clutch has proved superior to dry-type clutches for long life, low cost and performance. It features oil bath lubrication of the friction plates and clutch bearings, which eliminate overheating and lubrication problems commonly associated in dry-clutch applications.

Hydraulic oil is pumped in a fine spray into the centre of the clutch friction disc. Centrifugal force feeds the oil outwards over the friction faces to the housing wall where it is collected, filtered and returned to the main hydraulic tank.

A feature of the oil clutch is excellent inching, which is helped by the use of a clutch booster requiring only a light touch to operate it.

Cargo Loaders for London Airport

BOAC has recently introduced an 11½ ton cargo loader at London Airport which can reduce the time needed to load a Boeing 707 by half.

Exceptionally low chassis and cab.

The Cargomaster, made by Douglas Equipment Limited, Tewkesbury Road, Cheltenham, Glos, is driven from a cab which as the illustration shows is positioned low down on the vehicle front. This enables its body to come close to the aeroplane without the cab touching the fuselage. A hydraulic scissor-lift enables the body to be raised from 3½ to 12 ft above the ground to suit various types of aircraft.

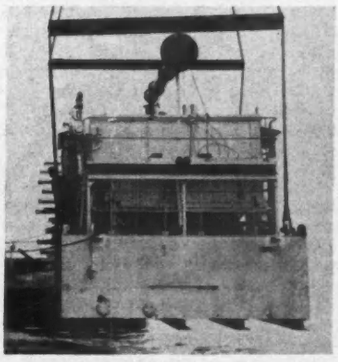
The body floor is made up of two conveyor belts which can work together or indepdently. A bridge extends from the body floor over the driver's cab and is also fitted with conveyor belts which can extend right to the inside of the aircraft's hold, giving easier and quicker handling of cargo.

BOAC, who have three such vehicles on order estimate that a complete load of passenger baggage weighing 4 tons for a 707 airliner could be unloaded in 10 minutes.

Drinking Water For the Sheikdom of Abu Dahbi

At the moment there are no drinking water supplies in the Sheikdom of Abu Dahbi on the Trucial coast in the Persian Gulf except those that are brought in at considerable expense.

Richardsons, Westgarth and Company Limited, Wallsend, Northumberland, have now supplied to the Sheikdom a fully self-contained sea-water evaporator which will produce 14,400 gallons of drinking water per day.



This sea-water evaporator has been designed to float on its own pontoon.

An unusual feature of this evaporator is the fact that it has been designed to float on its own pontoon. As there are no port facilities at Abu Dahbi, the plant will be lowered into the sea some miles off the coast and will be towed to the beach.

With the aid of a winch which forms part of the plant, it will be hauled up the beach and placed on a concrete foundation. It only remains to connect to a fuel supply, and to run sea water pipes to the plant, and the evaporator will be ready for use. The pontoon remains part of the plant and will be used for storage of the water produced.

Self-contained plants can be built to any size which can be handled as a unit, to operate on any normal fuel. In addition, the plant can be arranged to produce electric power to drive ancillary equipment such as fuel pumps, sea water pumps or brine circulating pumps.

Packaged Station Switching

Completely self-contained, the "Weatherbeater" packaged switching station is being produced by the English Electric Company Limited, Strand, London, WC2. It is a 33 kV unit which occupies little more space than a conventional indoor installation and much less than an orthodox outdoor one.

The "Weatherbeater" switching station.

Exterior weatherproofing is provided by the use of aluminium sheets thus dispensing with the need for a building, the only essential being a simple concrete raft. Capital costs and maintenance charges are consequently reduced to a minimum.

Standard units which are 16 ft 9 in high by 12 ft 3 in deep are used for the switching stations. A 1,200 A unit is 6 ft 6 in wide and a 1,600/2,000 A unit is 7 ft 3 in wide.

Each unit houses either an English Electric OKM4 or OKM5 single-tank oil-circuit breaker for current ratings up to 1,200 and 2,000 A respectively. Short-circuit ratings of 750 and 1,000 MVA are available in single busbar form.

Hand operated isolators are on both sides of the circuit-breaker. Built-in cable and, where required, busbar earthing equipment are included as well as hand operated safety shutters. The usual interlocks associated with metal-clad gear are provided. Isolators, earthing equipment and shutters are all operated from a single control point mounted on the side of each unit. Simple operation and quick mechanical interlocking ensure that the correct sequence is always followed.

Applying High Powered Epicyclic Gearing

Epicyclic gearing has not been extensively used in the past for high powered applications but the last decade has seen the introduction and acceptance of the Stoeckicht system.

IN ANY type of gearing the advantages to be gained from the use of helical teeth, compared with spur teeth, for the transmission of large powers are well known. Among them, particularly in high speed applications, one of the most important is that of noise. In many cases the use of double helical teeth as distinct from single helical gearing is considered desirable.

A paper entitled "The Application of High Powered Epicyclic Gearing for Industrial and Marine Use" was presented recently at the British Gear Manufacturers' Association's general meeting, and gave a report on applications of the Stoeckicht system. The authors were H. Norman G. Allen, and T. P. Jones, of W. H. Allen, Sons and Company Limited, Bedford. This article is based on extracts from the paper.

Stoeckicht gears—based on the principles of Dipl. Ing. W. Stoeckicht of Munich—in which the sunwheel has no bearings, have been successfully made with spur and single helical teeth, but the use of double helical gearing gives further advantages. There is better support for the floating sunwheel because the radial components of the tooth forces act in two separate planes and the equal and opposite axial forces on the sunwheel teeth also tend to have a steadying influence. Further, there is no tipping moment —as would be the case with single helical gears— to be resisted by the planet wheel bearings.

It is not surprising therefore that the most rapid and extensive progress with the Stoeckicht gearing has been made with the double helical form which was introduced some ten years ago. This type has proved to be much more suitable for the majority of industrial and marine applications than earlier forms of epicyclic gearing using spur or helical-form teeth.

Mechanical Considerations

The main difference between parallel-shaft gearing and epicyclic gearing is that, in the latter, the load is transmitted by more than one set of tooth contacts, but in order to take advantage of this it is of course essential to ensure that the load is equally divided between each planet wheel. The Stoeckicht principles ensure automatic load sharing by means of a divided annulus which is freely connected to the torque reaction member by means of a gear-toothed coupling. Once this load sharing is established, advantage may be taken of the fact that more than one set of toothed components is used in the transmission of power to give considerable reduction in the size of gearing needed for any given application.

Principal Components.—Fig. 1 shows a cross sectional arrangement of a complete gear form. The teeth of the wheels are of course most important and must be correctly designed and manufactured, but it is also essential to make sure that the planet wheel spindles are correctly spaced. The planet carrier is robustly made.

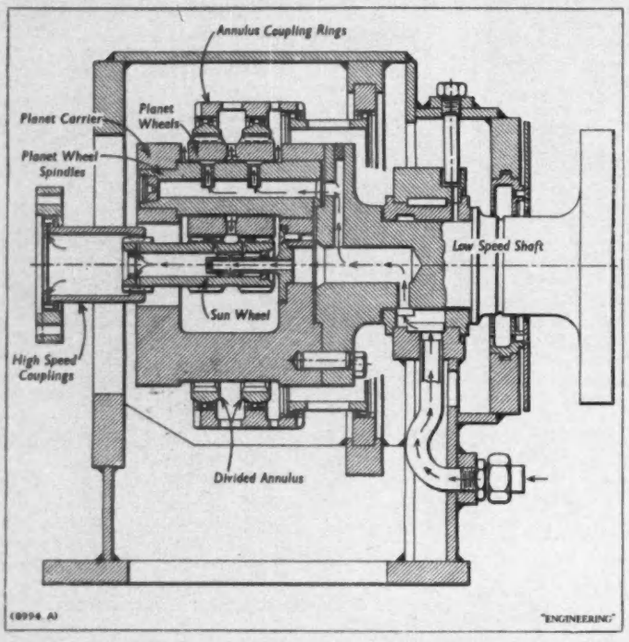


Fig. 1 (left) Sectional arrangement of a typical Allen-Stoeckicht gear showing the flow of lubricating oil.

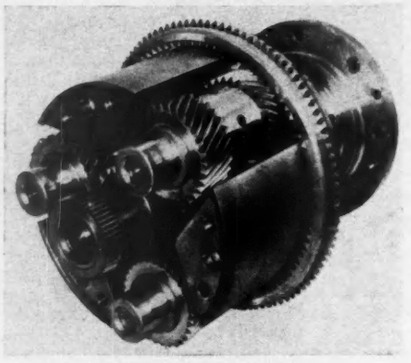


Fig. 2 (above right) Double helical epicyclic gear used in Ruston and Hornsby's TA 1,450 h.p. gas-turbine. Planet gears are hardened and ground.

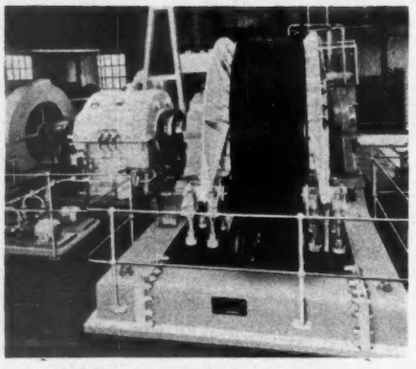


Fig. 3 (right) English Electric mine hoist equipment incorporating Allen-Stoeckicht gearing.

No radial or transverse forces from epicyclic gears act on the gearcase except the torque reaction which may be taken up on the circumference of the gearcase. Stresses on the casing arising from outside sources cannot affect the tooth contacts unfavourably. This is particularly important in marine applications where it is sometimes difficult to ensure that the gear casing will be completely free from stresses and deflections induced by the hull.

The planet wheel bearings of an epicyclic gear are particularly interesting and in most cases the best bearing is obtained by using a spindle faced with white metal on which the planet wheels rotate. This form of bearing has several advantages, among which is the fact that the load on the white metal is always in the same direction and consequently there is less chance of the bearing failing by fatigue than if a bush lined with white metal were used in the wheel.

Efficiency.—Epicyclic gearing is at least as efficient as parallel shaft gearing, and a number of factors which are inherent in epicyclic gearing make it slightly better. In applications where the planet carrier revolves, the relative pitch line velocity between the sun and the planet wheels is reduced and this leads to an increase in efficiency in the tooth engagements. The complete elimination of bearings from the high-speed rotating member removes the most prolific sources of loss in any form of gearing.

Accessibility.—Epicyclic gears are sometimes criticised as being inaccessible compared with parallel-shaft gears, but it is possible to arrange such gearing so that the whole rotating assembly can be conveniently removed without affecting the alignment of the bearings of the driving or driven machines.

Coaxial and Parallel Shafts.—Not only are reductions in size advantageous from the point of view of saving weight and space and ease of handling, but the coaxial arrangement of input and output shafts often leads to an improved arrangement of machinery installation. However it is clear that a coaxial arrangement of shafts does not always meet requirements and in installations where a change of centre between driving and driven members is desirable, parallel-shaft gears are obviously more suitable.

Applications

Gas-Turbines.—It was not surprising that when Stoeckicht double helical gears where first introduced they were regarded with suspicion by some engineers. This was natural as previous attempts to introduce high power epicyclic gearing had not been successful. This form of gearing had established itself in the automobile and aircraft industries, although in aircraft there had been considerable difficulties.

However, at the time, many gas-gurbine designers were pioneers, applying aircraft techniques to industrial and marine fields and some were quick to appreciate the advantages of compact gear scientifically designed and accurately made. Their foresight with regard to epicyclic gears proved correct and they have been able to fit and forget them.

Ruston and Hornsby have had over ten years experience with such gears (see Fig. 2) in their TA 1,450 h.p. gas-turbine units, and 125 of them have been supplied for service all over the world, some in pumping installations operating under primitive conditions.

Continued on next page

Steam Turbines.—In most ships the demand for electrical power is rapidly increasing at a time when engine room space is being cut down. The advantages of saving in length given by the small sizes of epicyclic gears have been quickly appreciated and an increasing number of ship owners now regard their use as conventional, particularly for large ratios. The CPR ships Empress of Britain and Empress of England include turbo generators incorporating epicyclic gears to transmit 1,600 h.p. reducing 7,000 r.p.m. to 600 r.p.m.

The Steel Company of Wales have recently installed a high pressure/back pressure topping turbine manufactured by Richardsons Westgarth (Hartlepool) Limited under licence from Brown Boveri and Company Limited of Switzerland. The inlet steam conditions are 3,000 lb per sq. in, 1,050° F and the back pressure can vary from 620 to 670 lb per sq. in. The turbine runs at 9,500 r.p.m. and the 9,500 kW alternator at 3,000 r.p.m. The use of such steam conditions called for particular care in design and the turbine speed was chosen to keep down the mass of the turbine casing to minimise the effects of temperature gradient.

Industrial Transmissions.—The use of epicyclic gearing is not confined to gas or steam turbines, however. At the time of writing the gear illustrated in Fig. 3 is the largest dimensioned Stoeckicht gear in service, although larger gears have been constructed and tested. It is capable of transmitting 3,200 h.p. with a reduction ratio from 486 to 64 r.p.m. giving a torque on the low speed shaft of 260,000 lb ft. The annulus diameter is 43 in and the weight of the gear is 9 tons. It has been in service for four years on sinking duty at the Monktonhall colliery of the National Coal Board. The small size and weight of epicyclic gearing allows reductions to be made in the civil costs of towers for such applications.

Future Trends

The last decade saw the introduction of Stoeckicht double helical gears and the authors have attempted to report on the successful application of these gears in a wide variety of installations. Progress has been most rapid in general industrial applications and in constant speed turbo drives. There is no indication that the limits of power, torque or speed are in sight and it is believed that the next ter years will see further development in all these respects.

Possibly the next major progress can be expected in marine propulsion gearing. There are many ships operating at shaft horse powers up to 10,000 which is well within established experience, while results obtained from such applications as mine hoist gears give confidence in meeting the type of loading to be expected in marine propulsion gearing.

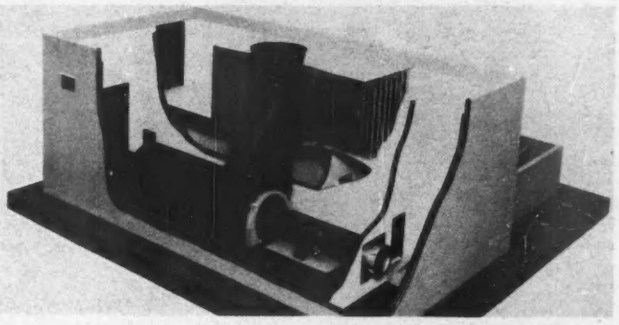
In future not only will epicyclic gears be used as straight reduction gears, multi-speed gears, reduction-reverse gears and declutchable gears, but in the author's opinion epicyclic gearing has a part to play in combination with very large parallel shaft gears Increasing speeds of prime movers and increasing powers required—for example, by very large tankers—make the gear problem such that possibly the limit is being reached with parallel shaft gearing, and already hardened gears are being considered. In this connection, epicyclic gears can probably play a useful part to give in a compact way the initial reduction in say, applications where two turbines are combined through a parallel shaft gear to drive one propeller shaft.

Aero Engine Developed for Peak-Load Turbo-generator

A reputation has already been built up for the Bristol Siddeley Olympus turbojet engine as used in the RAF's Vulcan V-bomber. Here it has proved reliable and economical as a power plant.

Now the same engine has been developed to assume a new role: this time as the prime mover in a 15 MW gas turbogenerator set which the CEGB is to install at Hams Hall power station near Birmingham. The installation, which is intended to go into operation in September, 1962, is intended to show the ability of the gas turbine to meet the requirements of national electricity authorities and large industrial concerns, both for peak load operation and for maintaining a supply of electricity in an emergency.

For its high output, the unit is compact and light, and is claimed to have excellent fuel consumption—0·752 lb per kW-hr. In addition, low capital cost, its suitability for automatic operation under remote control and the very simple maintenance required make it an attractive proposition. Quick starting is achieved due to the low thermal inertia of the engine, which means that the plant is always in readiness to meet emergencies.

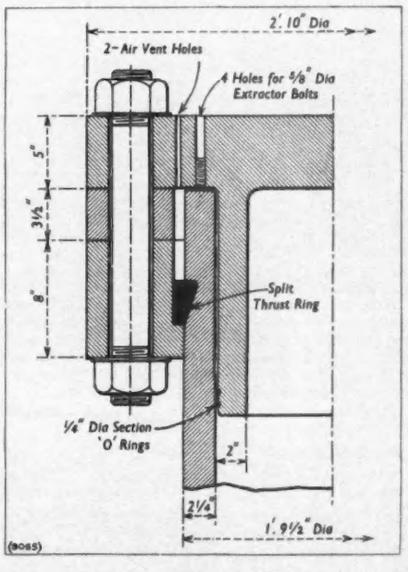


The prime mover in this 15 MW turbo-generator set has been developed from the Bristol Siddeley Olympus aero engine. The set is intended to demonstrate the ability of the gas turbine to meet peak load and emergency generation for electricity authorities and industrial concerns.

The complete set is 52 ft 6 in long and because of its light weight, heavy foundations are unnecessary thus keeping to a minimum construction costs.

A separate free power turbine converts the energy of the waste gases from the gas generator into shaft power and is directly coupled to the alternator which was made by the Brush Electrical Engineering Company Limited, Loughborough, Leicestershire.

Weldless Closure for Pressure Vessel



A case recently arose when it was desirous to utilise two existing cylinders for a high-pressure application. The closures of the cylinders were unsuitable for the particular job, so it was decided to adapt them. The firm concerned were Constructors John Brown Limited and the work was done at their Research and Development Station, Leatherhead, Surrey.

The existing cylinders were 14 ft long by 1 ft 9½ in outside diameter, with a wall thickness of 2¼ in. It was necessary to cut both cylinders and to flange them in such a way as to give a full bore of 1 ft 5 in. Chemical analysis of the steel showed it to be of too high a carbon content for safe welding, made worse by the vessels working through a temperature range of −20 to +70° C at a pressure of 3,650 lb per sq. in.

Designs using split rings on the outside of the vessel were considered, but difficulty was always found in stressing, because if the vessel was carrying the longitudinal stress and the hoop tension, there was insufficient metal available for machining a groove for a split ring. Final design (shown in the sketch) provided the top flange with a skirt extending into the bore.

To effect a closure, welding was not permissible.

The skirt carried two O rings at its inner end so that the vessel did not carry hoop stress at any point beyond the O rings, thus allowing a groove to be machined in the vessel for the split ring. Split ring and groove were machined to close limits and the position of the groove was such that discontinuity stresses were avoided. The whole of the end thrust due to internal pressure is carried by the split ring. Bolts and flanges are lighter than would normally be used because the bolts do not have to apply gasket forces.

Two ¼ in diameter holes were drilled through the top flange to provide a free path for any gas that might leak past the O rings. There has been no evidence of deterioration but each time the flanges have been dismantled new O rings have been fitted. The second O ring is fitted in case of failure of the other. Hydrogen and ammonia vapour are contained in the vessel so that failure of a ring would be dangerous.

The 3½ in thick distance piece is only fitted because the billets for the flange and ring had already been obtained.

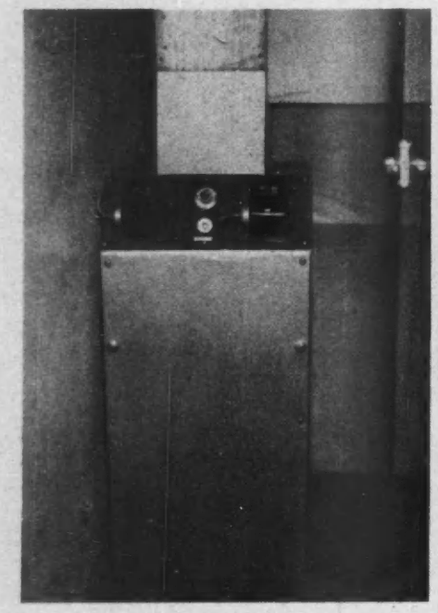
Hydraulic pressures of up to 7,500 lb per sq. in have been applied to the vessels at atmospheric temperatures with no signs of leakage.

Heat Pump House

WHAT is probably the first "speculative" house to be built in this country with a heat pump as the motive power for the central heating and hot water supply was recently completed at Caversham in Berkshire. The source of heat is the larder with an auxiliary extractor in the garage.

The heating system is basically one of warm air circulation, with a small fan driving the air over the condenser coils. An alternative arrangment includes a coil to heat the water supply with a switch to cut it out in very cold weather so that the whole available heat can then be used on the warm air system. An immersion heater in the hot water tank then takes over that part of the work, under thermostatic control.

The compressor and condenser units are contained in a single casing, in this instance built under the stairs. It is shown in the first illustration. The compressor is a twin cylinder machine driven by a 1 h.p. motor, the whole being supplied as a sealed unit. The refrigerent is compressed to 150 lb per sq. in and allowed to expand in the evaporator to 5 lb per sq. in, absorbing heat in the process.



Heat pump and condenser are contained in one unit built under the stairs.

About 15 lb of refrigerant is contained in the circuit and, since the pump runs at 1,400 r.p.m. and handles about 3 lb per minute, the whole quantity is circulated every five minutes, giving a heat flow of 12,000 Btu per hour. Thus 4 kW of heating is obtained for each kW of electricity used by the motor.

This rate would not be sufficient for the three bedroomed house in which the system is installed if the weather was very cold, so a 3 kW element is included in the air circuit to make up when necessary. This is controlled by a thermostat coupled with the main thermostat that regulates the whole system. A controlled proportion of warm air is recirculated.

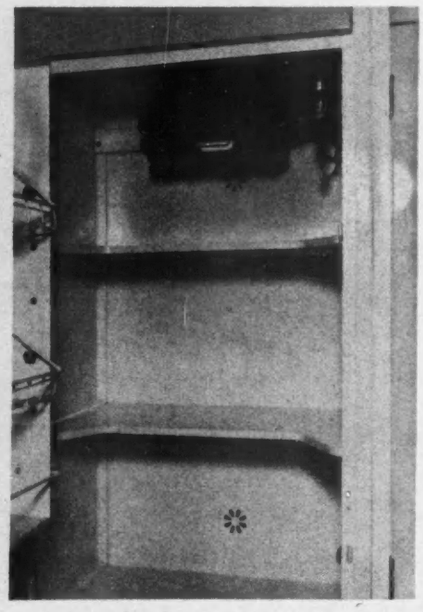
The main evaporator unit is mounted in the larder as shown in the second picture. Immediately below the coils is an ice box, and the larder temperature is controlled by an expansion valve that regulates the flow of refrigerent. When the larder is cooled to the set temperature, the flow is diverted to the auxiliary evaporator which, in this case, is in the garage.

Although primarily intended for installation in new buildings, the heat pump equipment is available through electrical contractors for fitting in existing houses. The approximate cost according to Jonmil Building Developments Limited (16 Carlisle Street, London, W1) who produced the system, is about £220 for the central heating and refrigeration unit (including an allowance for installation) or, £250 for the outfit that includes the water heater, again allowing for installation.

These cost figures make an interesting comparison with those given in the booklet "Central Heating in your Home" produced by the Institution of Heating and Ventilating Engineers. (ENGNG., p. 464, 30 Sept. 1960). There the cost of warm air installation using a boiler fired by coke or gas is quoted as £265 for an output of 20,000 Btu per hour. Note that this does not include water heating or refrigeration. The Mark I Jonmil heat pump unit gives 12,000 Btu per hour for an estimated cost installed of £220 with the cooling of the larder thrown in. On the other hand a warm air furnace system, gas fired, would cost about £180 for a 20,000 Btu output.

Running costs are not so easy to compare, as a common basis is required. The 20,000 Btu warm air system using coke is estimated to cost about £20 to £29 a year in fuel. Gas, burnt in a boiler, would cost from £26 to £36 a year, but if burnt directly in a warm air furnace from £28 to £39 a year. Reckoning electricity at 1*d* per unit, the heat pump system could be run continuously for 300 days for a cost of £30, although to this must be added the additional heating by the booster element during really cold weather—a very variable factor. Even so, the cost is quite favourable for the heating season is not usually reckoned to last for more than six months (say 180 days) and the refrigeration and water heating are thrown in "for free." Maintenance of the heat pump system should be very low and the simplicity and ease of control, coupled with the cleanliness and completely automatic operation are big points in its favour.

The heat for circulation is extracted in the main from the larder, which is thereby cooled.



Two previous heat pump units have been produced for the domestic market, but both were for water heating only. They were built to stand in the larder, cooling it, and were connected into the hot water system, which they raised to a temperature of 140° F. The high initial cost, blamed by both makers on the added purchase tax, limited their sale so severely that one soon came off the market. This Jonmil development is on a different line and may well prove popular.

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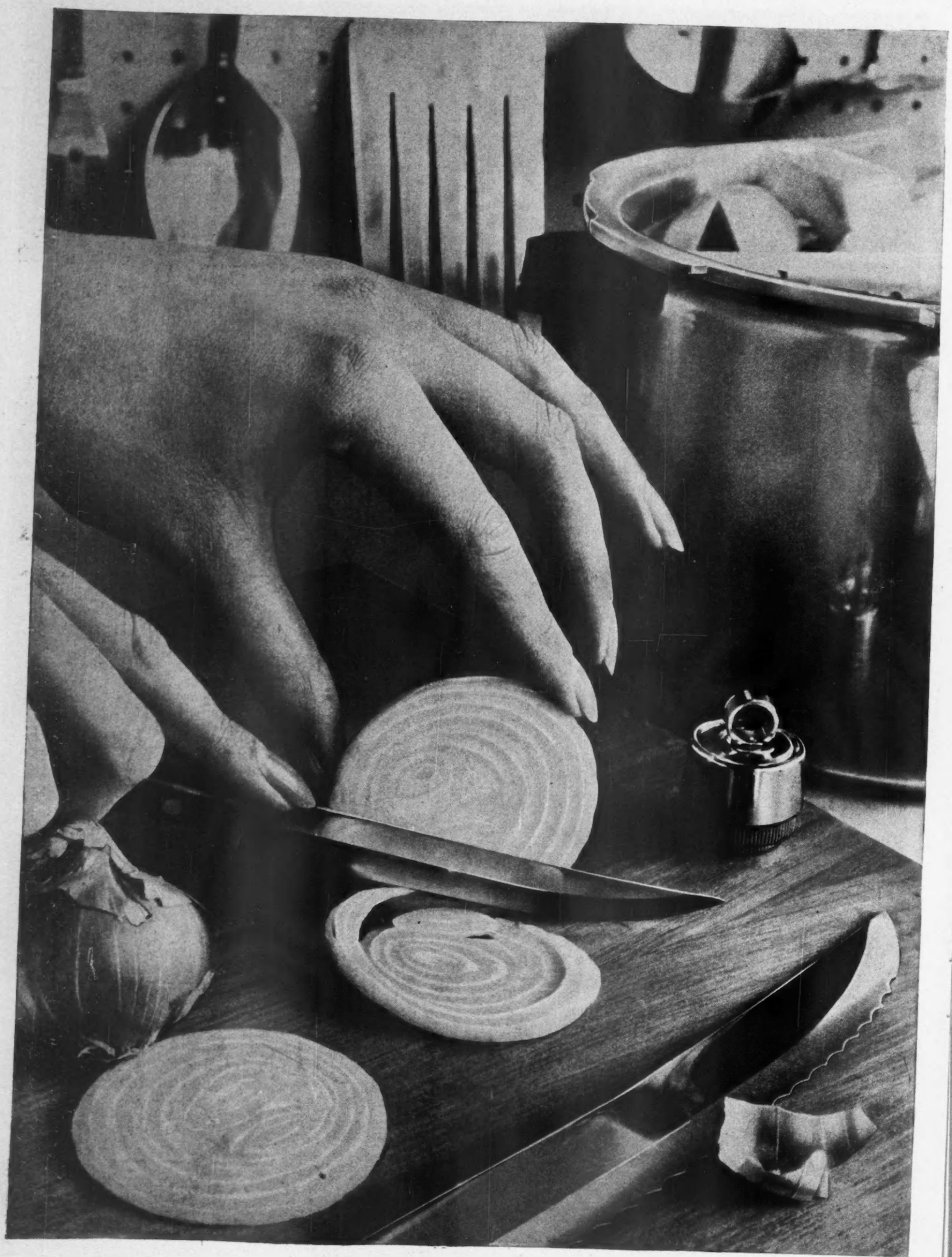

Prestige are keen on Coal

OVER THE PAST twenty-one years one name has come to predominate in the homes—and particularly the kitchens—of housewives who appreciate well-designed, efficient domestic utensils. That name is Prestige. Such is the tremendous popularity of Prestige housewares today that three huge factories at Burnley, Derby and Blackburn are now in full production to meet the ever-growing demand for the Prestige range.

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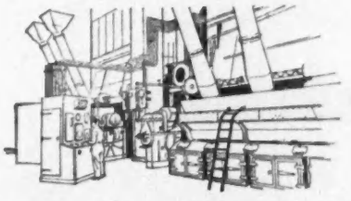
Coal Supplies the Power at Prestige's three factories at Burnley, Derby and Blackburn

Mr. Eric Horner, Works Engineer, comments:—

"A regular watch has been kept on the cost of various fuels other than coal, affecting the price of steam raised. But after studying costs over several years it is felt that only some absolutely unpredictable changes in fuel costs could unseat coal from its position as the most economical fuel for our use. When the Company first operated in this country in 1937, coal was the obvious fuel chosen for one steam raising plant. But in 1946 and '47, as a result of the national fuel crisis, serious consideration was given to alternative fuels. Although detailed calculations showed that upwards of 70% efficiency can be readily obtained on coal firing, it was necessary to fit alternative means of firing on one boiler due to the temporary shortage of coal. It was therefore possible to make exhaustive trials—and the results confirmed calculations that coal is the most economical fuel. Later, as coal became available to meet our full requirements, *we reverted again to using only coal for steam raising.*

In 1956, to meet increased steam demand at the Burnley Plant, a third and larger coal fired boiler was installed. Because of the pending "Smoke Control Regulation" this installation was designed so that grit arrestors could readily be fitted if required. However, this has not been necessary, as the periodic reports from the Public Health Department have always given us a clean report."



Some key facts and figures about the consumption of coal in the Prestige boilerhouses:

Boilers: ..... 7, including four economics
Method of firing: ..... Mainly coking stokers
Steam pressure: ..... Up to 120 p.s.i.
Steam temperature: ..... 340°F.
Continuous max. rating: ..... 53,600 lbs of steam per hour
Annual fuel consumption: ..... 5,220 tons of coal

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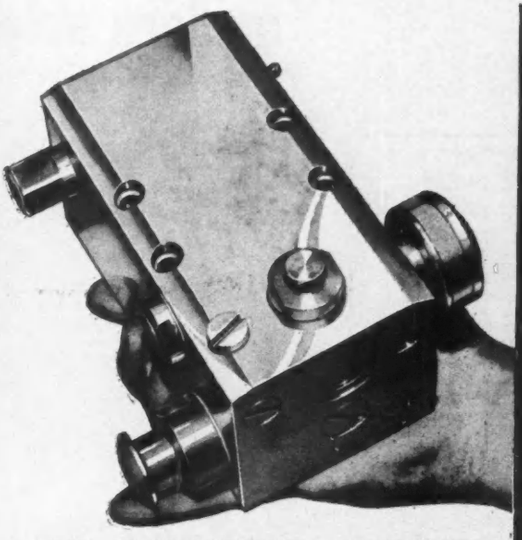

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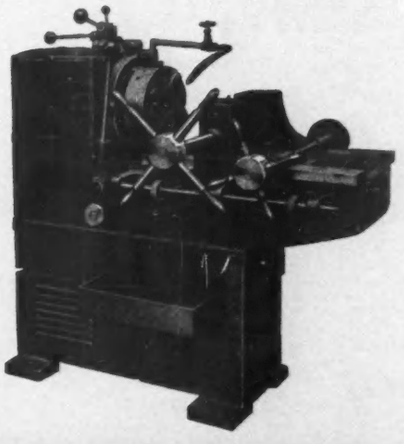

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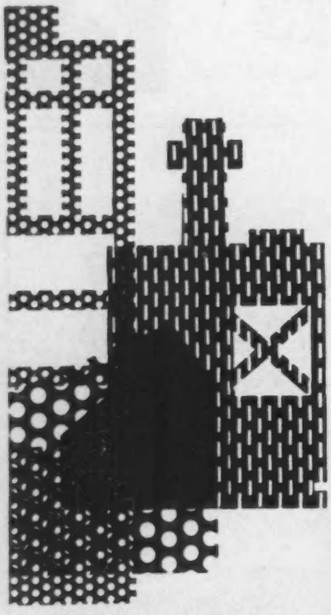

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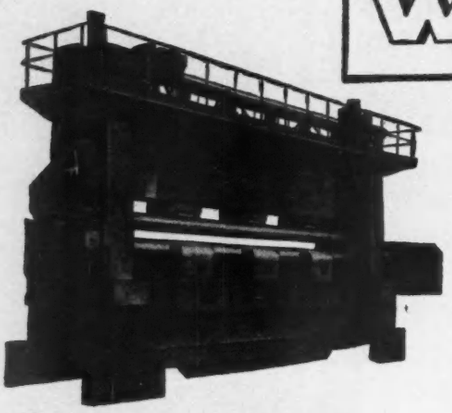

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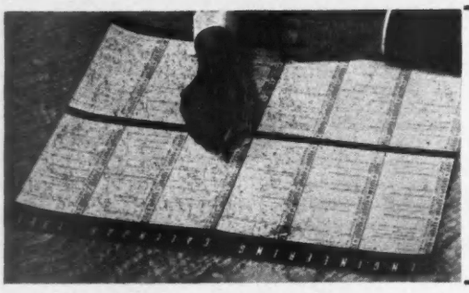

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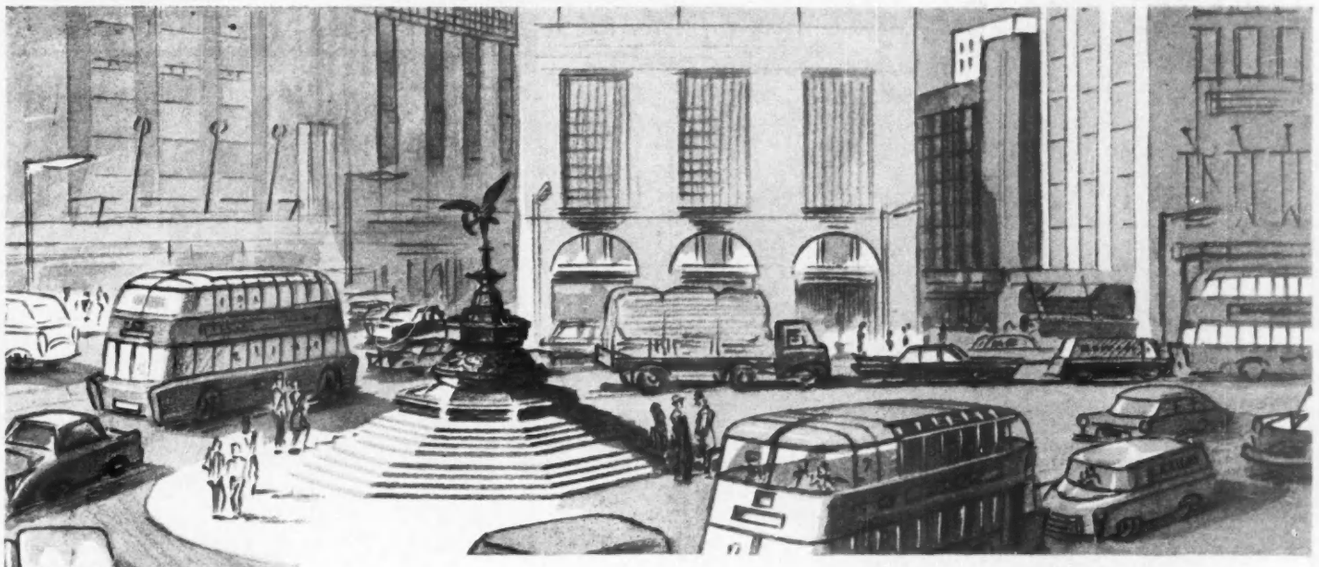

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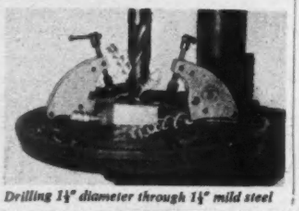

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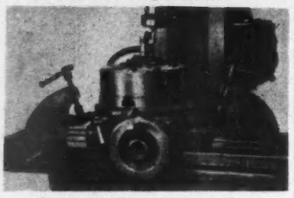

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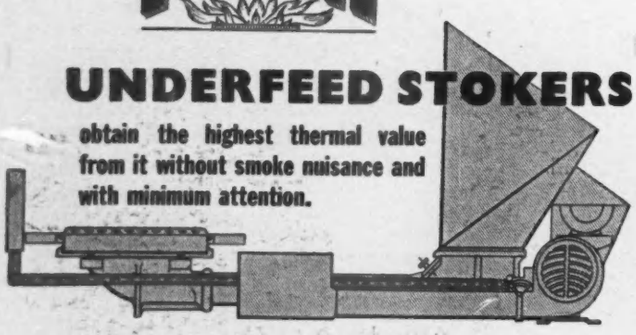

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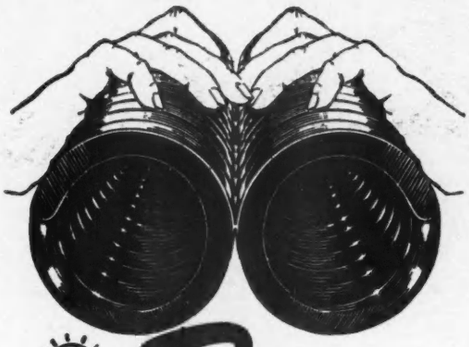

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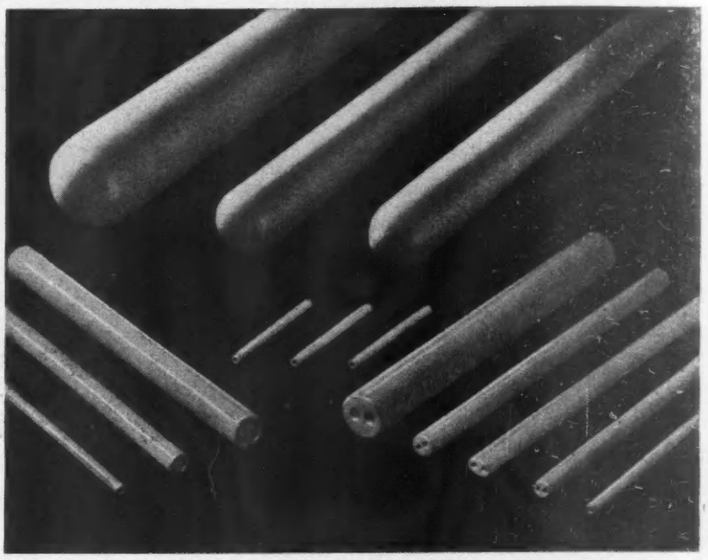

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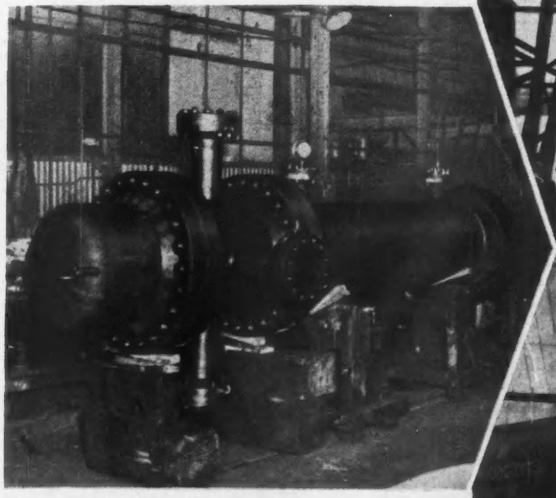

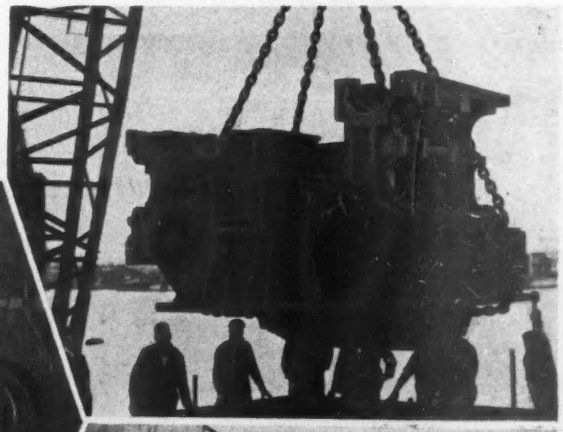

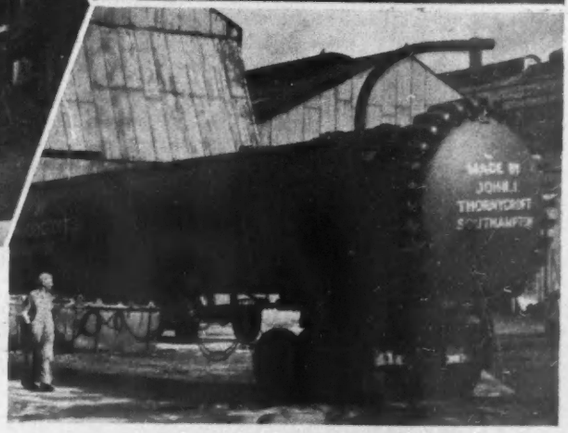

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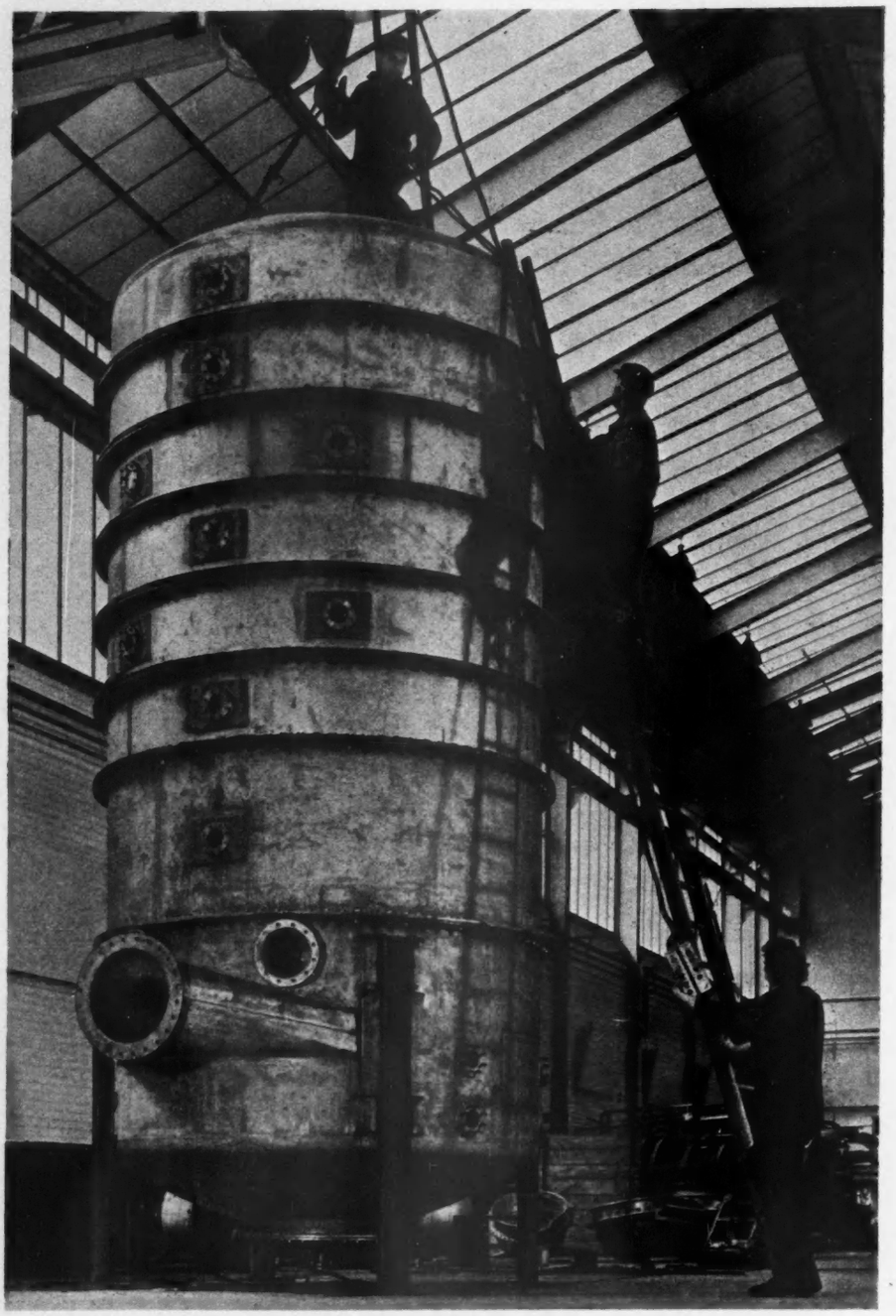

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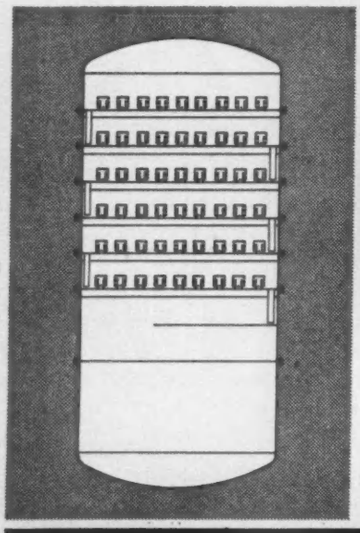

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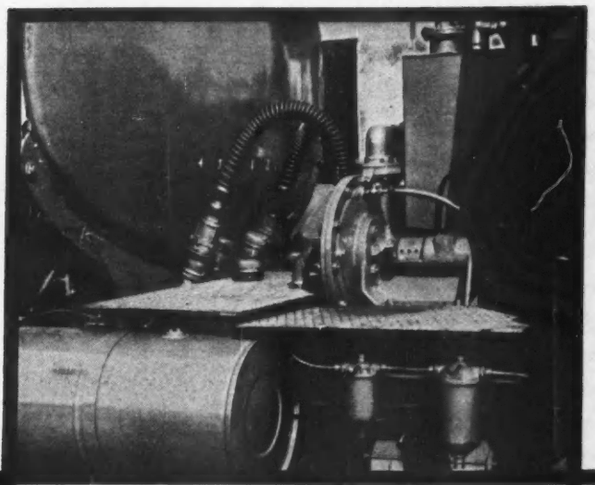

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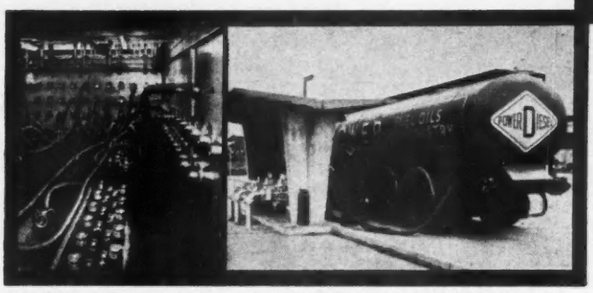

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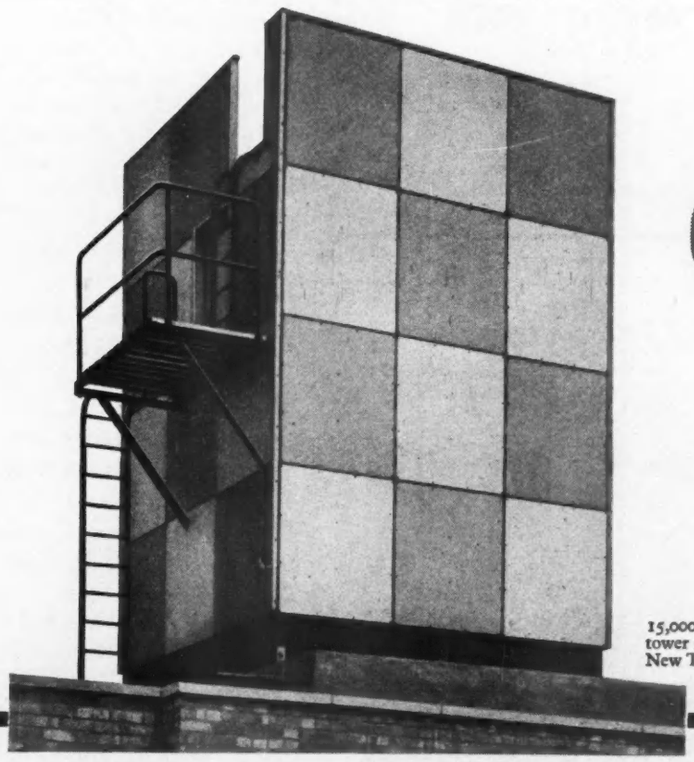

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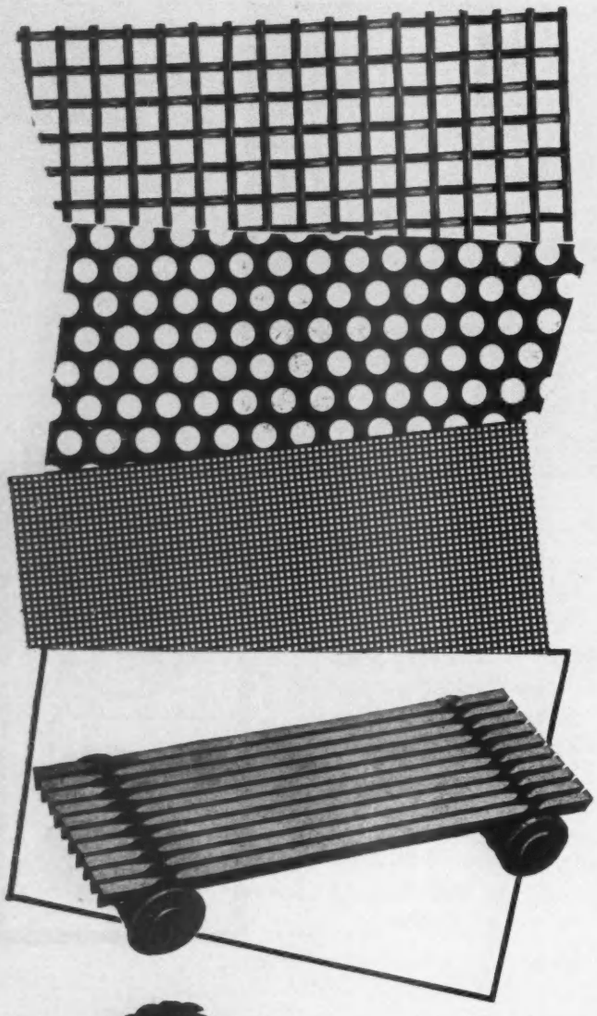

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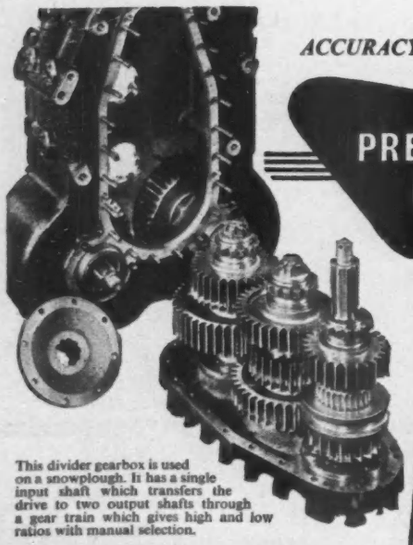

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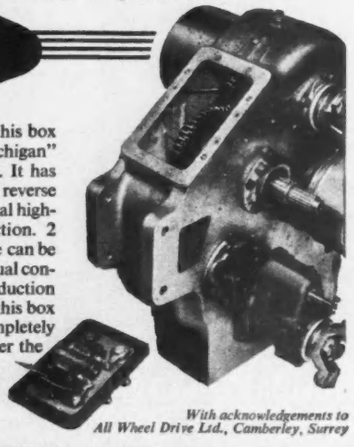

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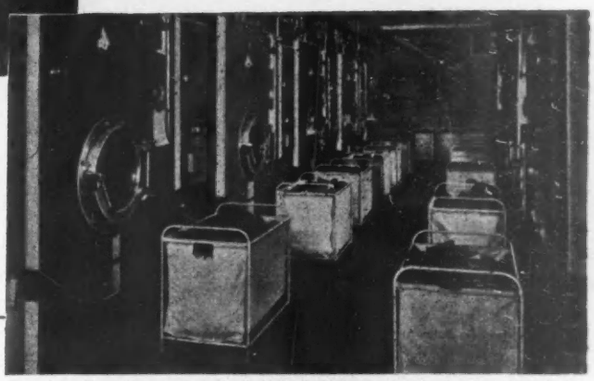

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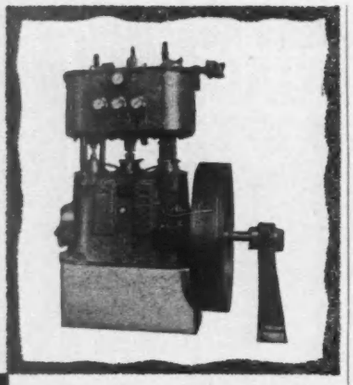

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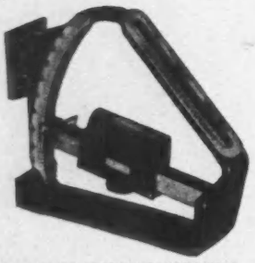

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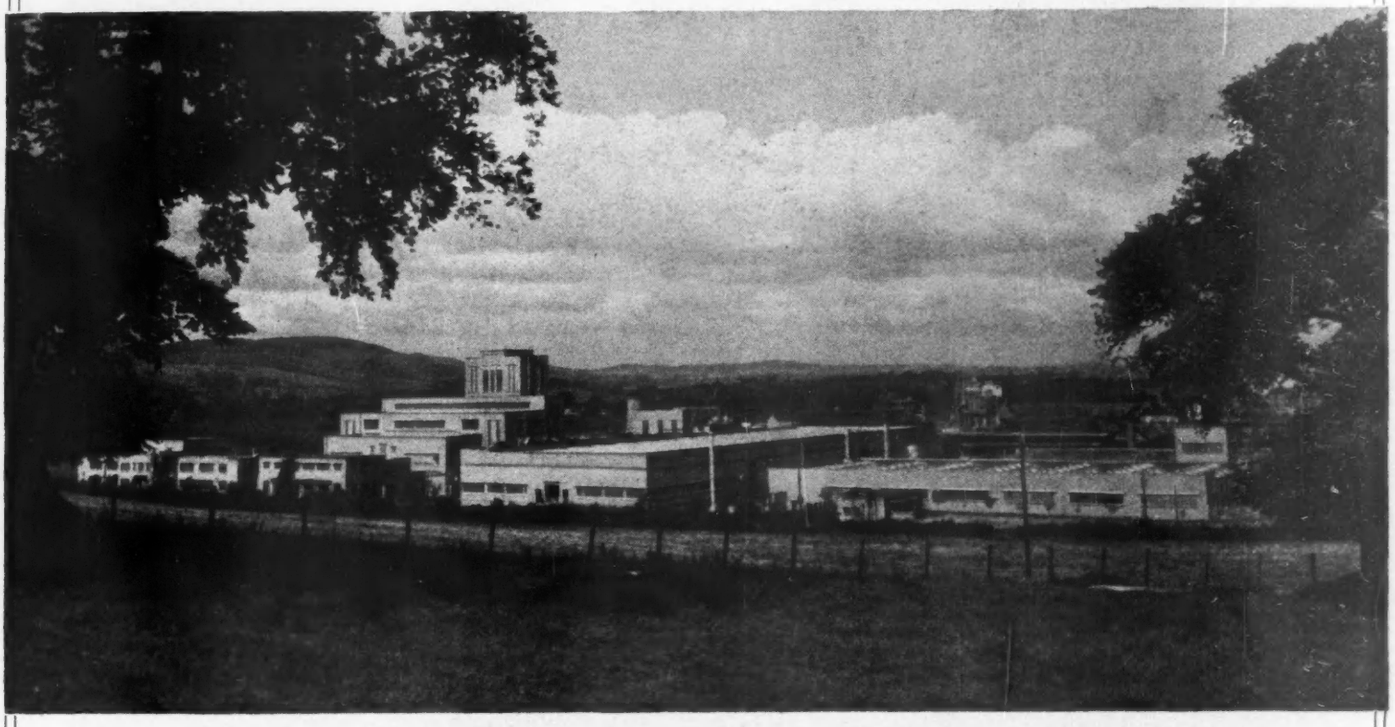

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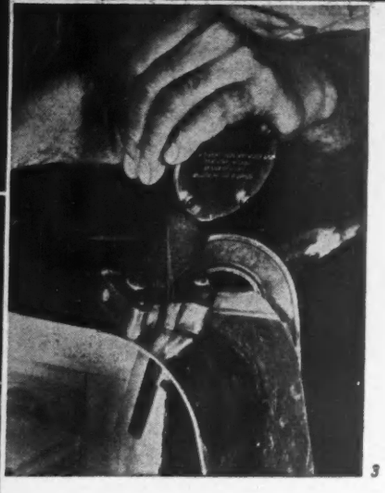

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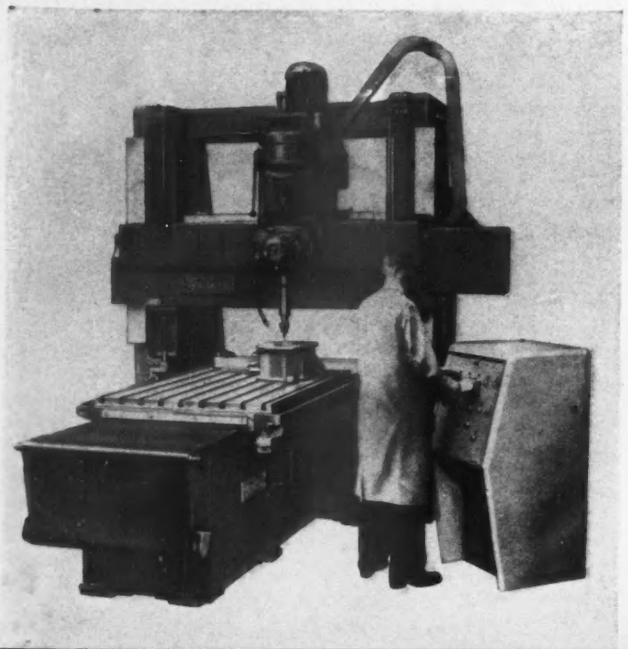

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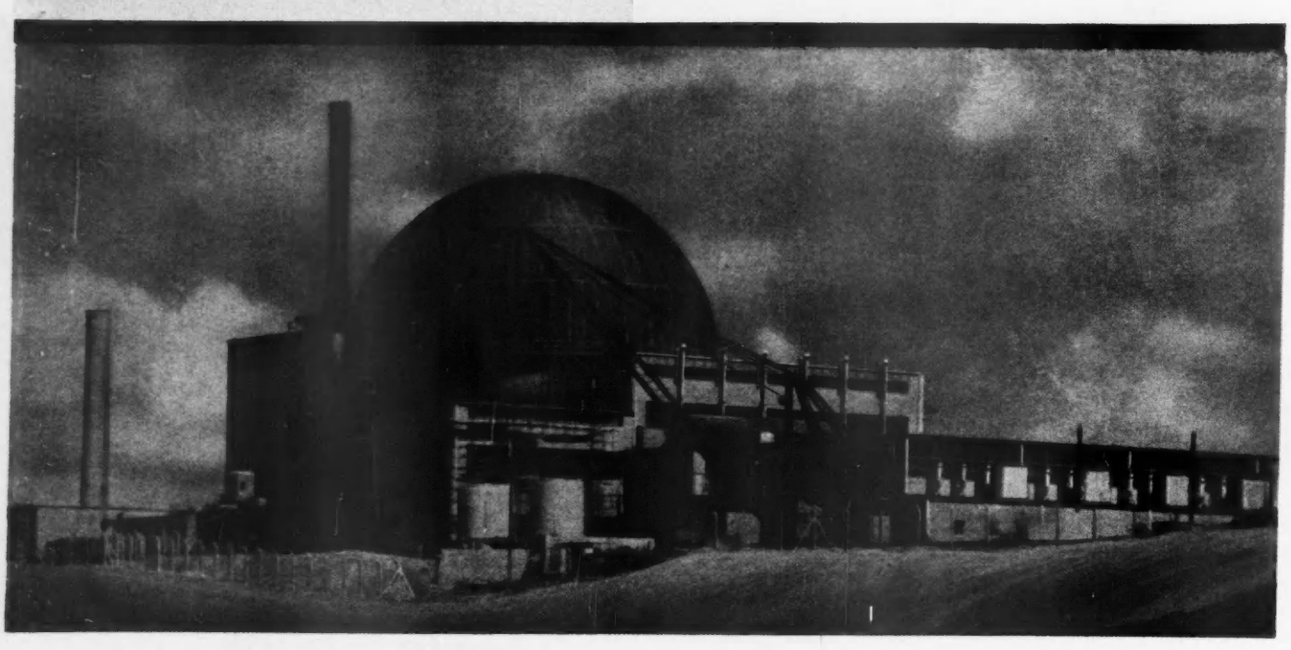

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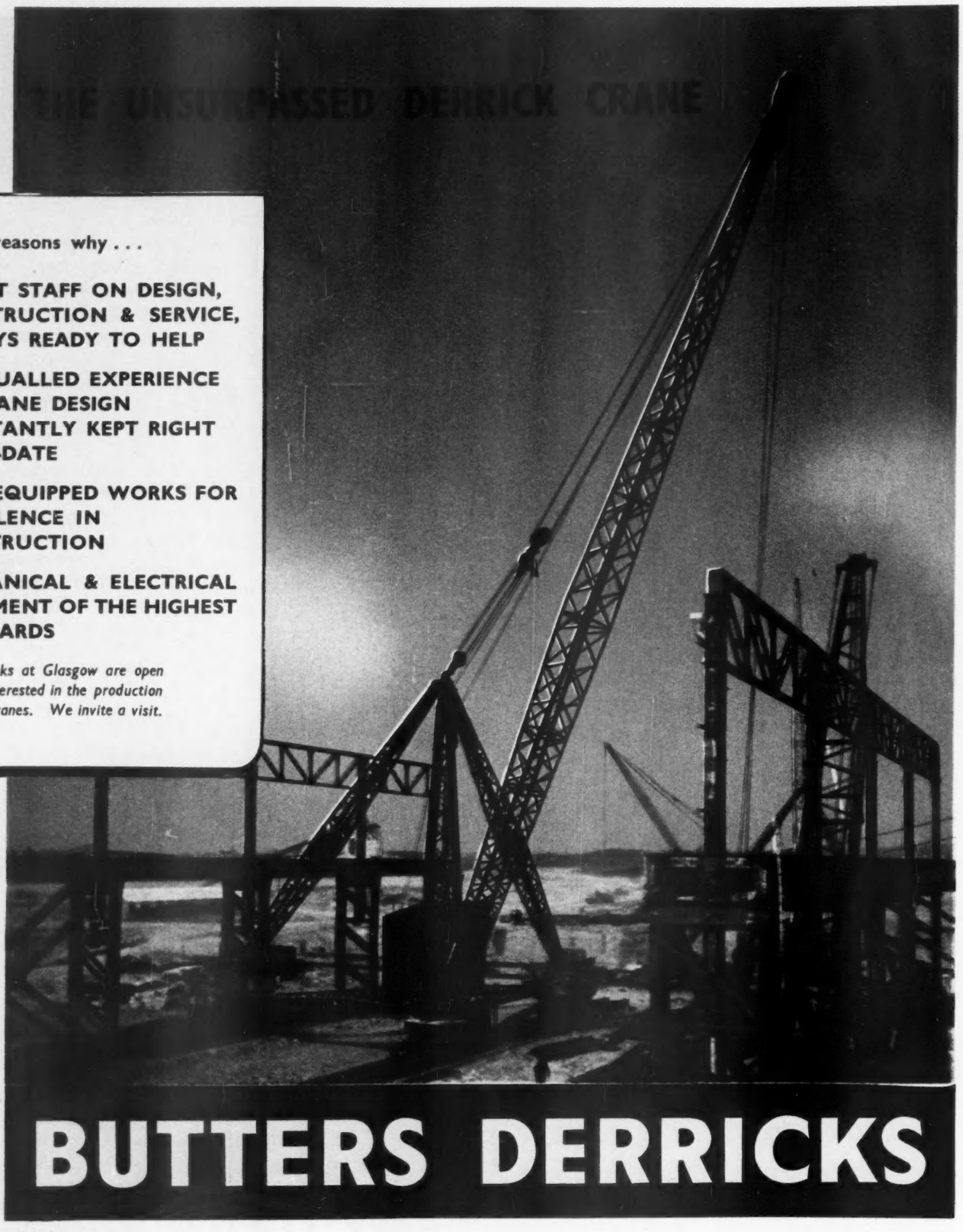

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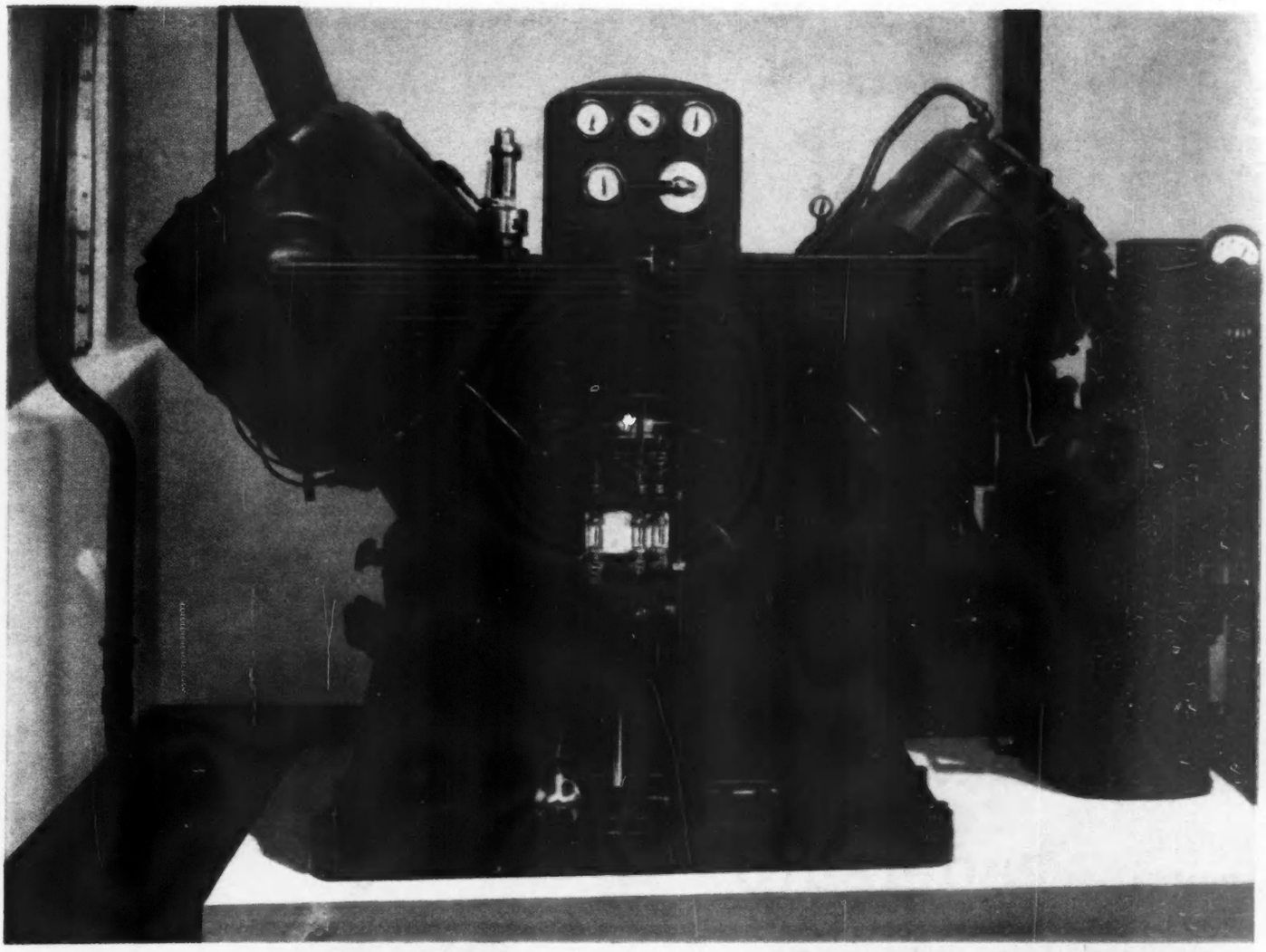

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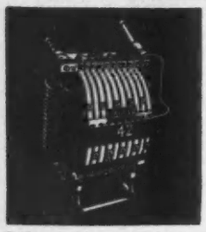

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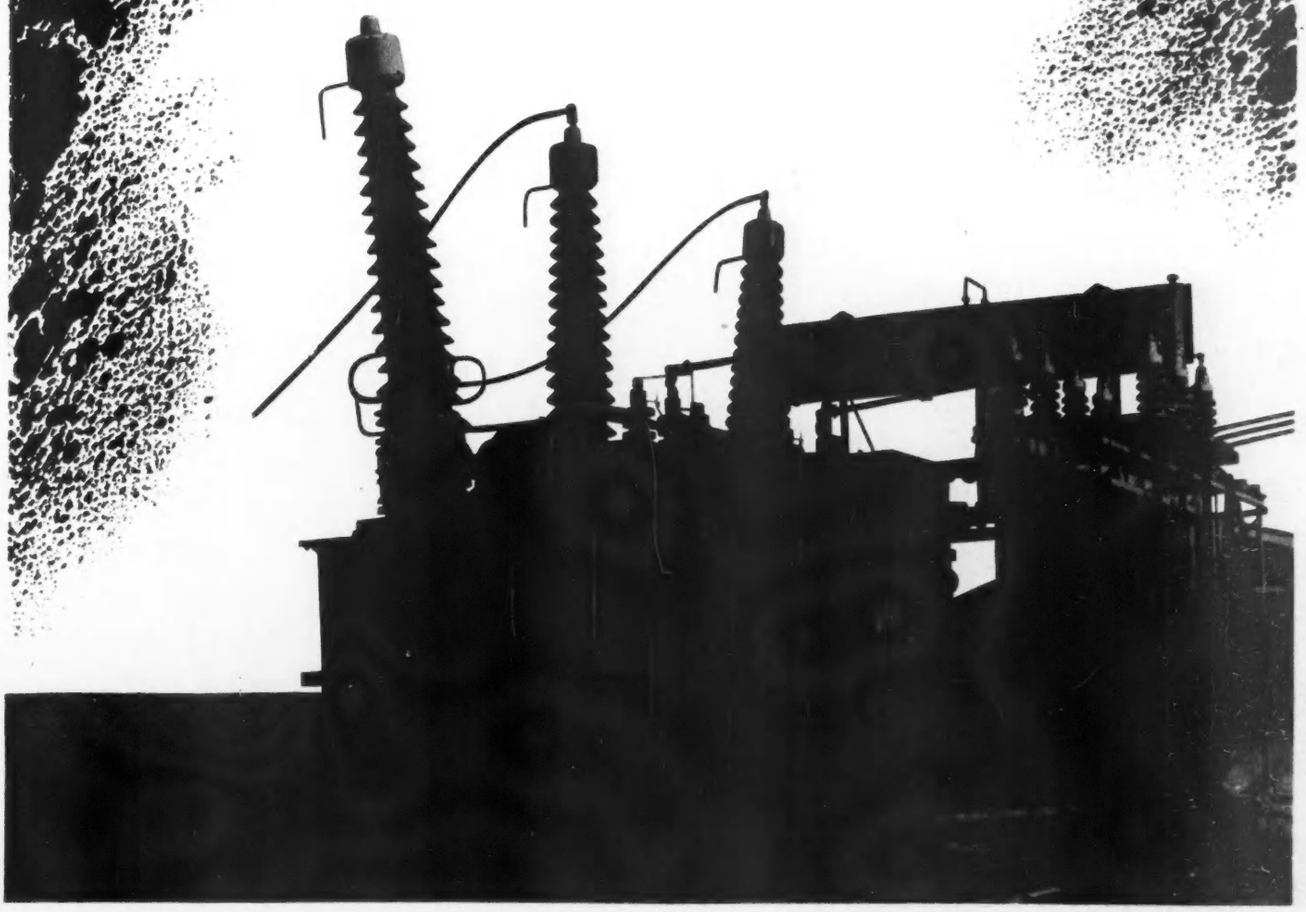

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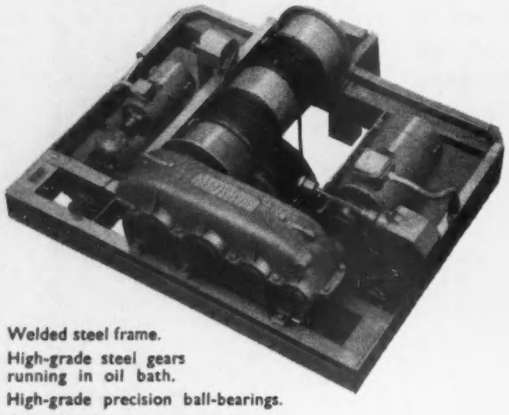

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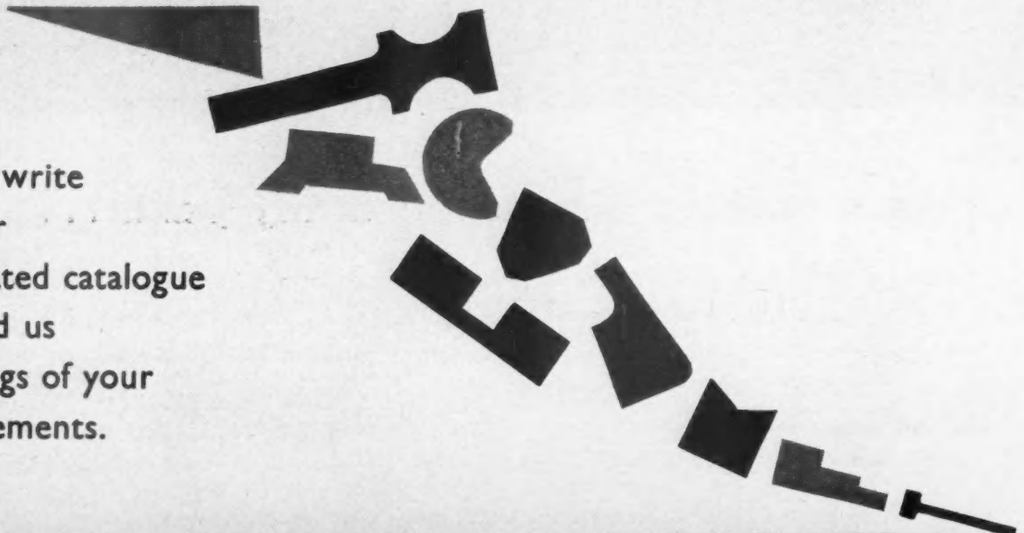

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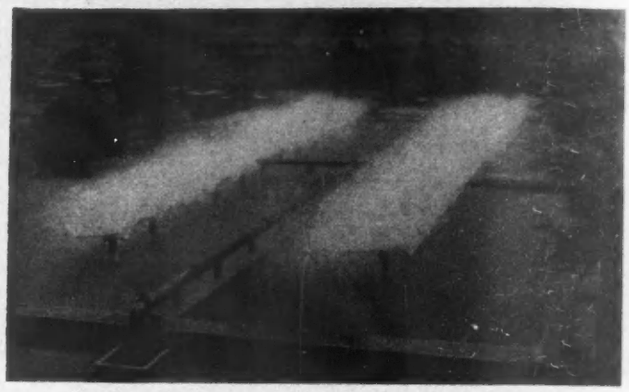

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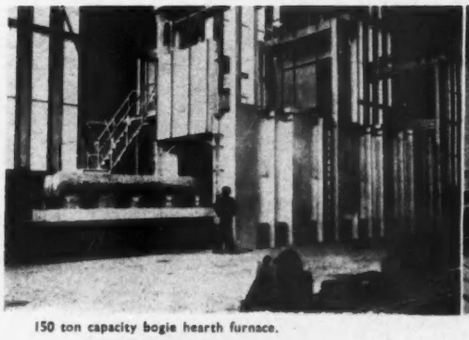

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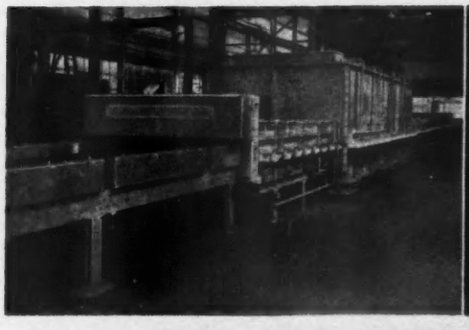

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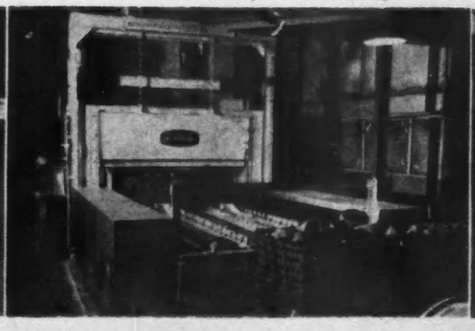

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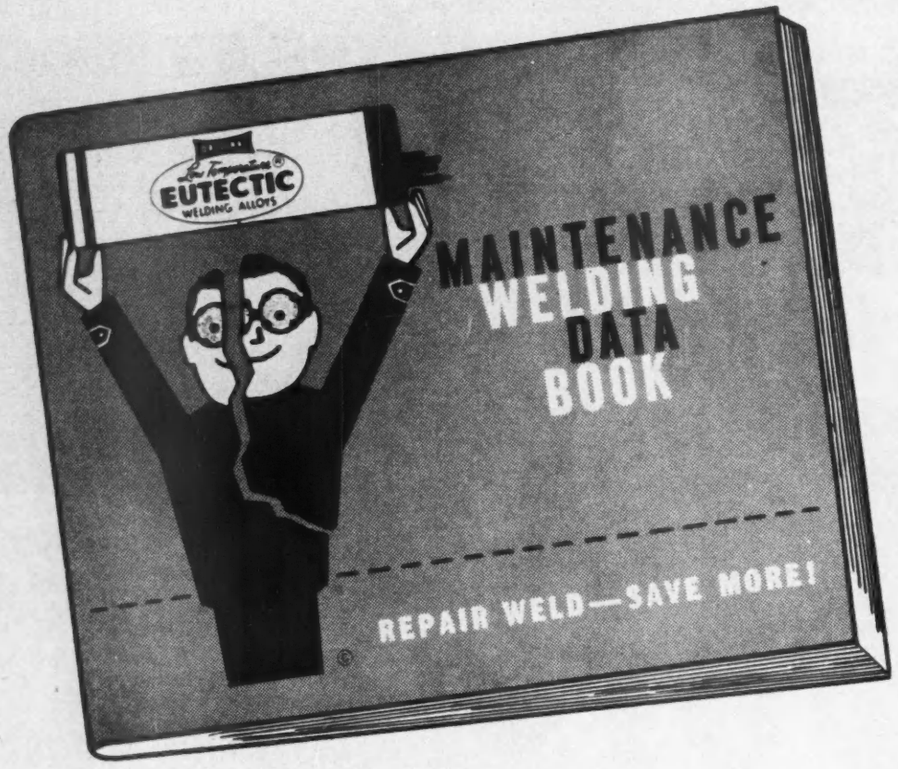

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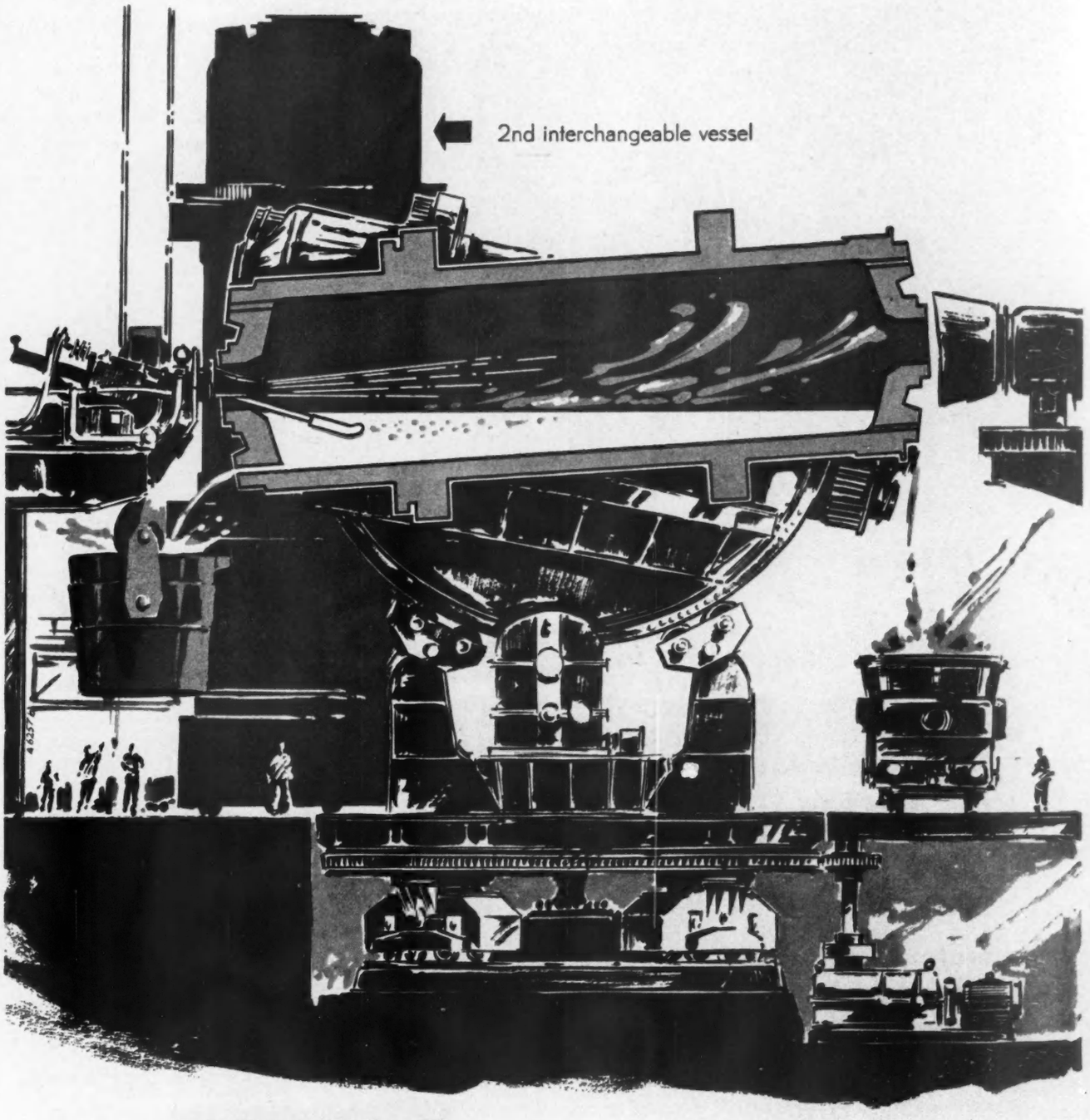

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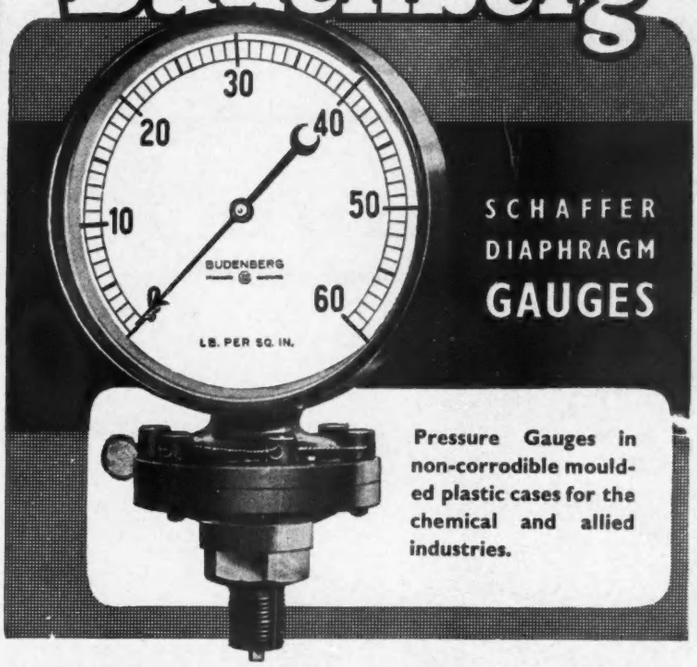

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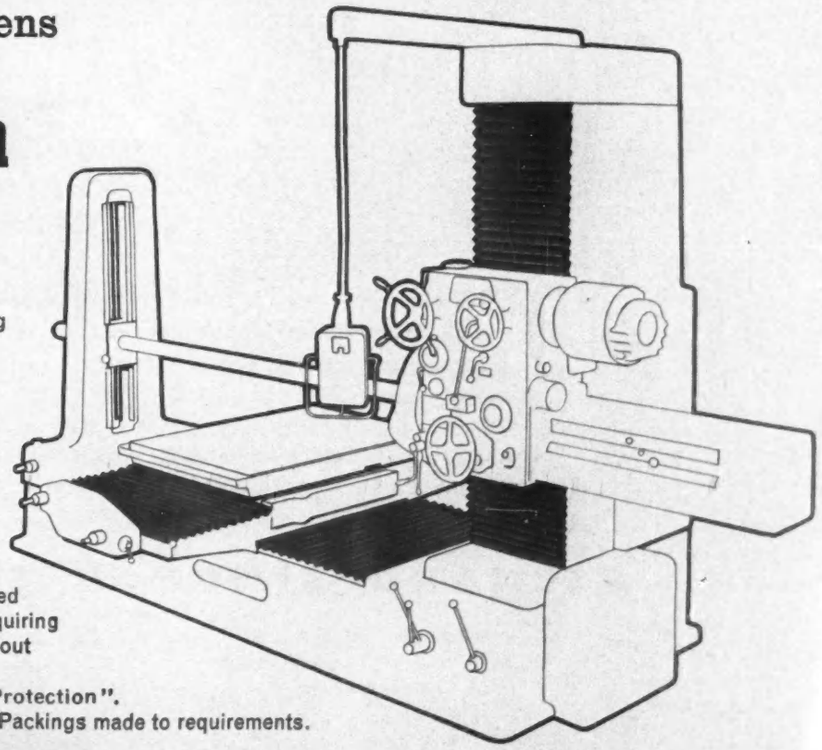

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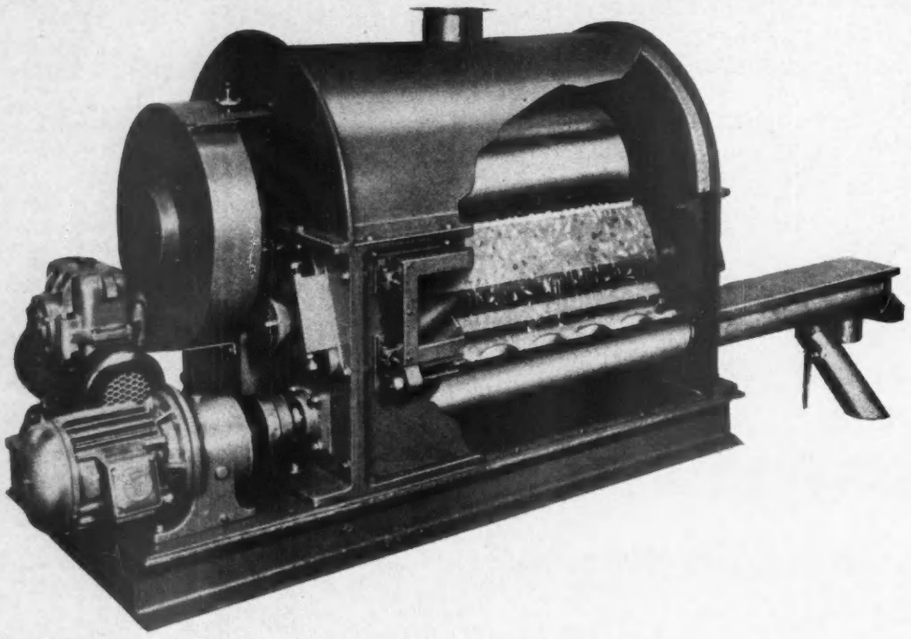

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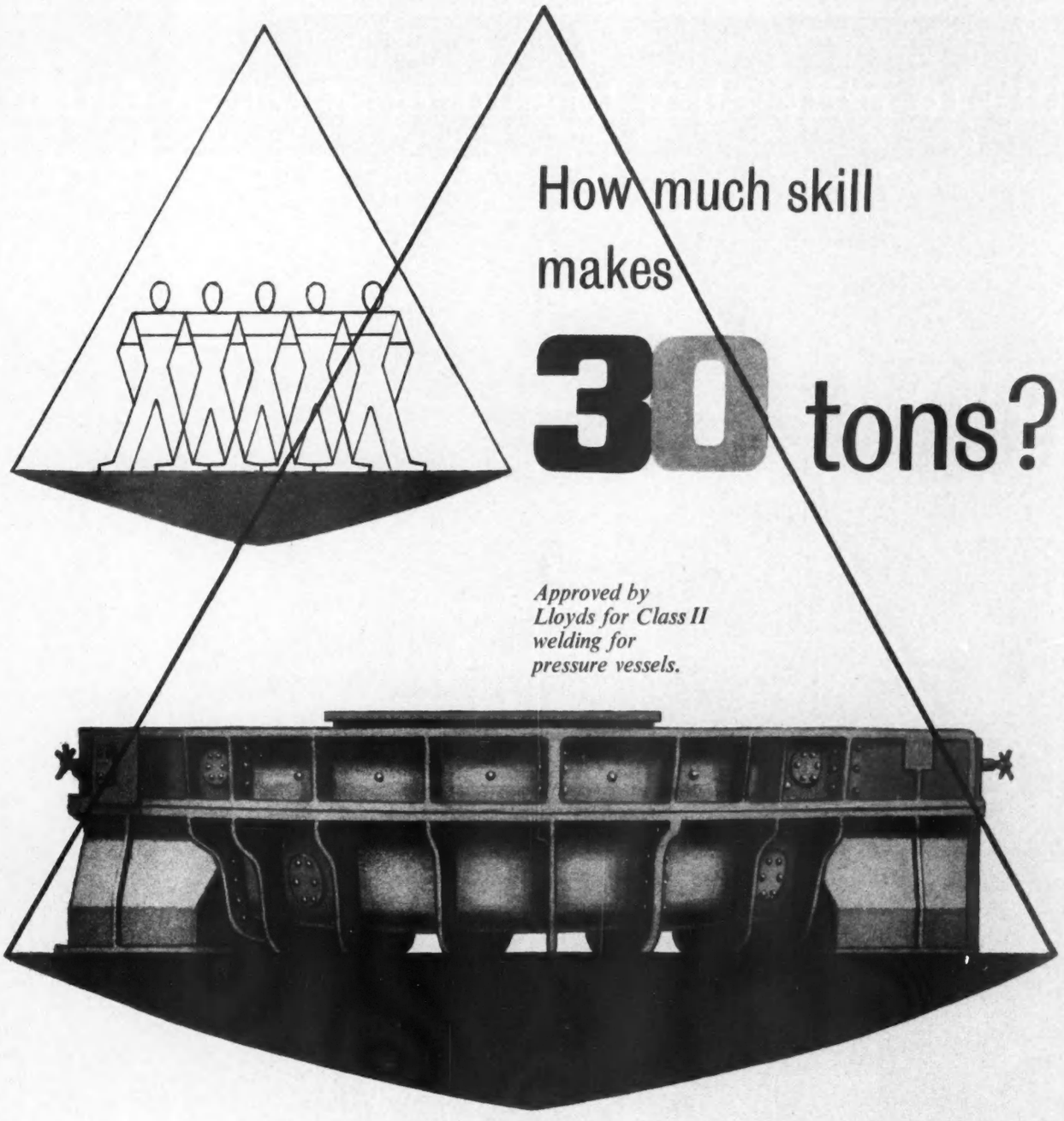

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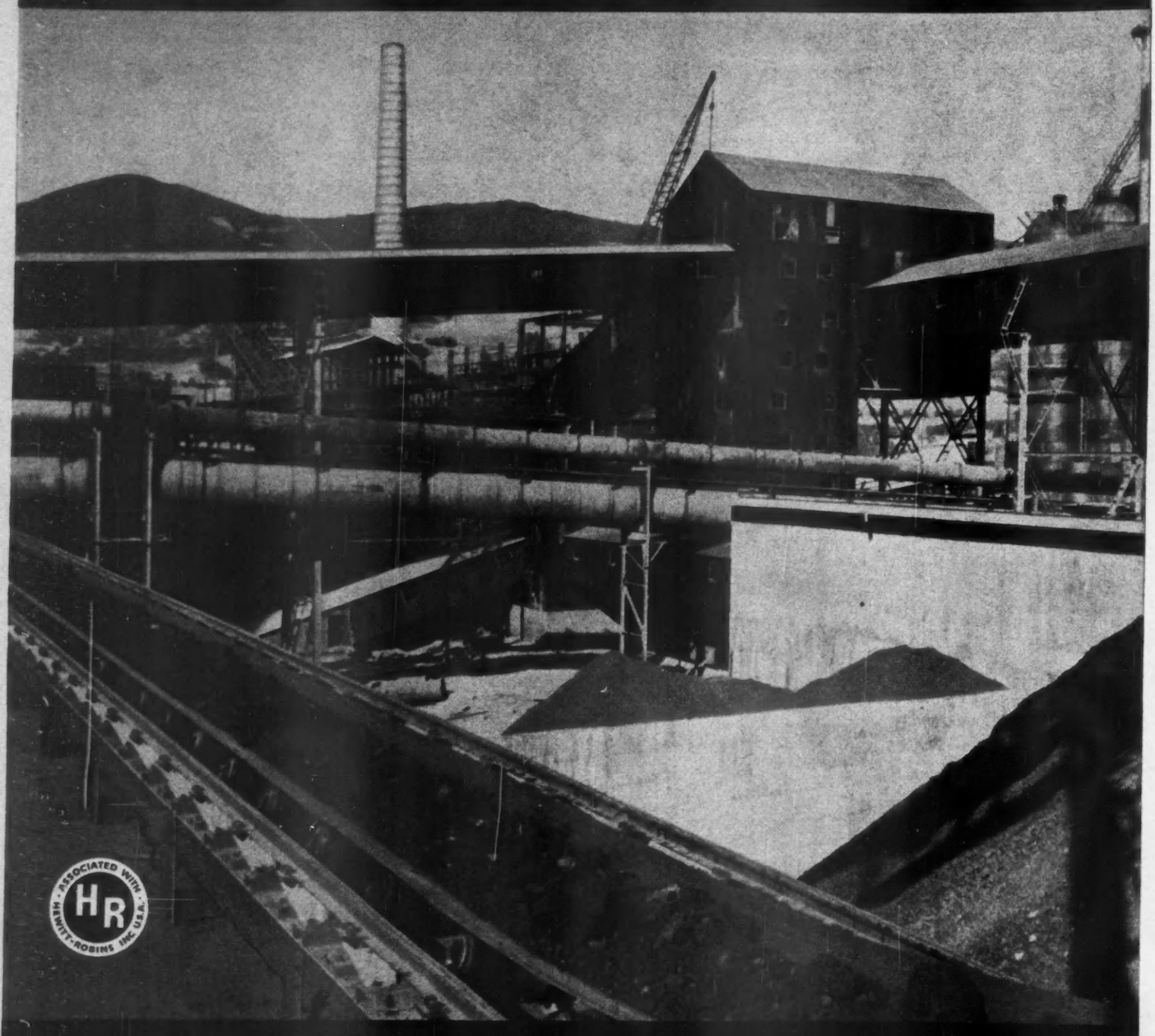

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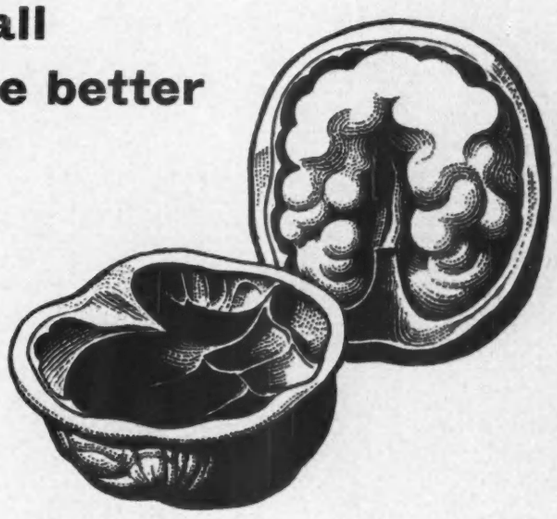

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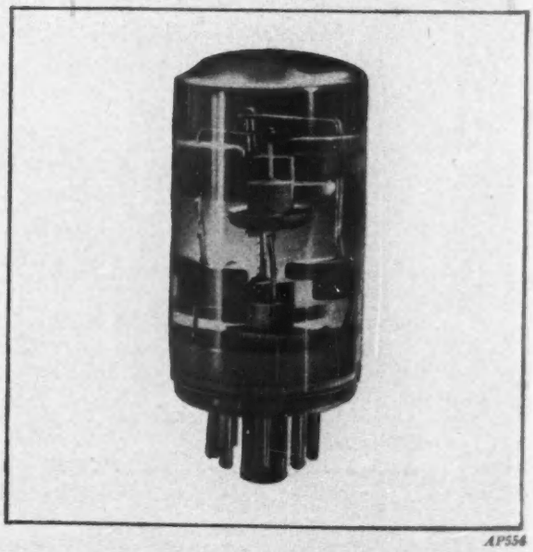

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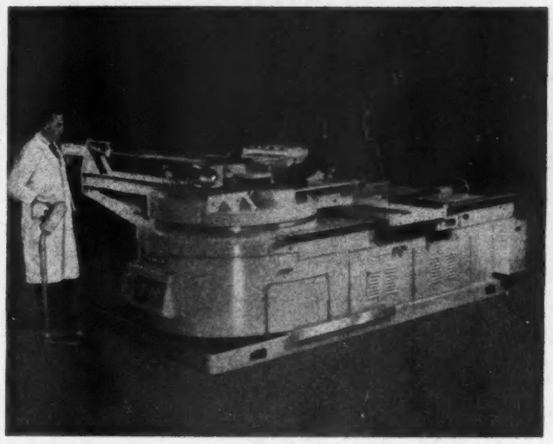

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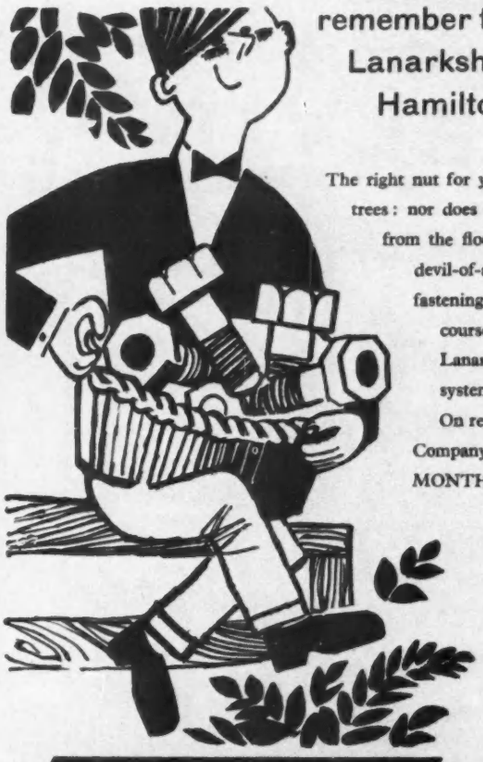

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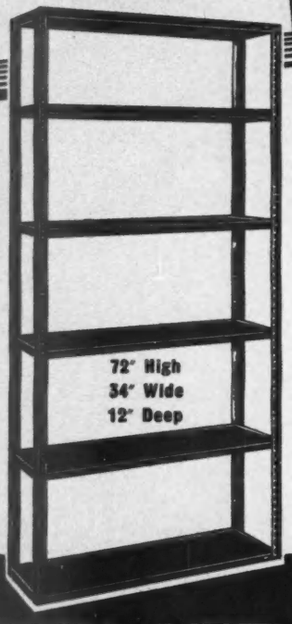

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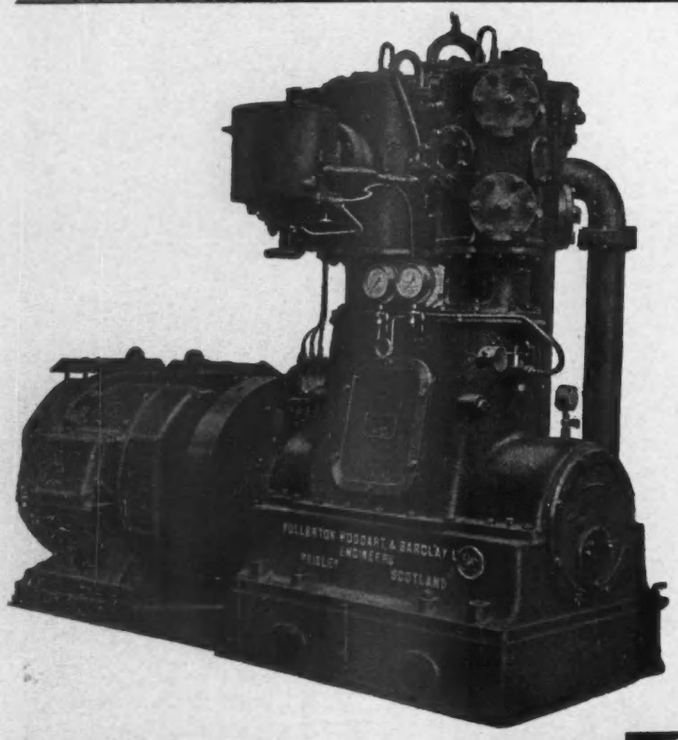

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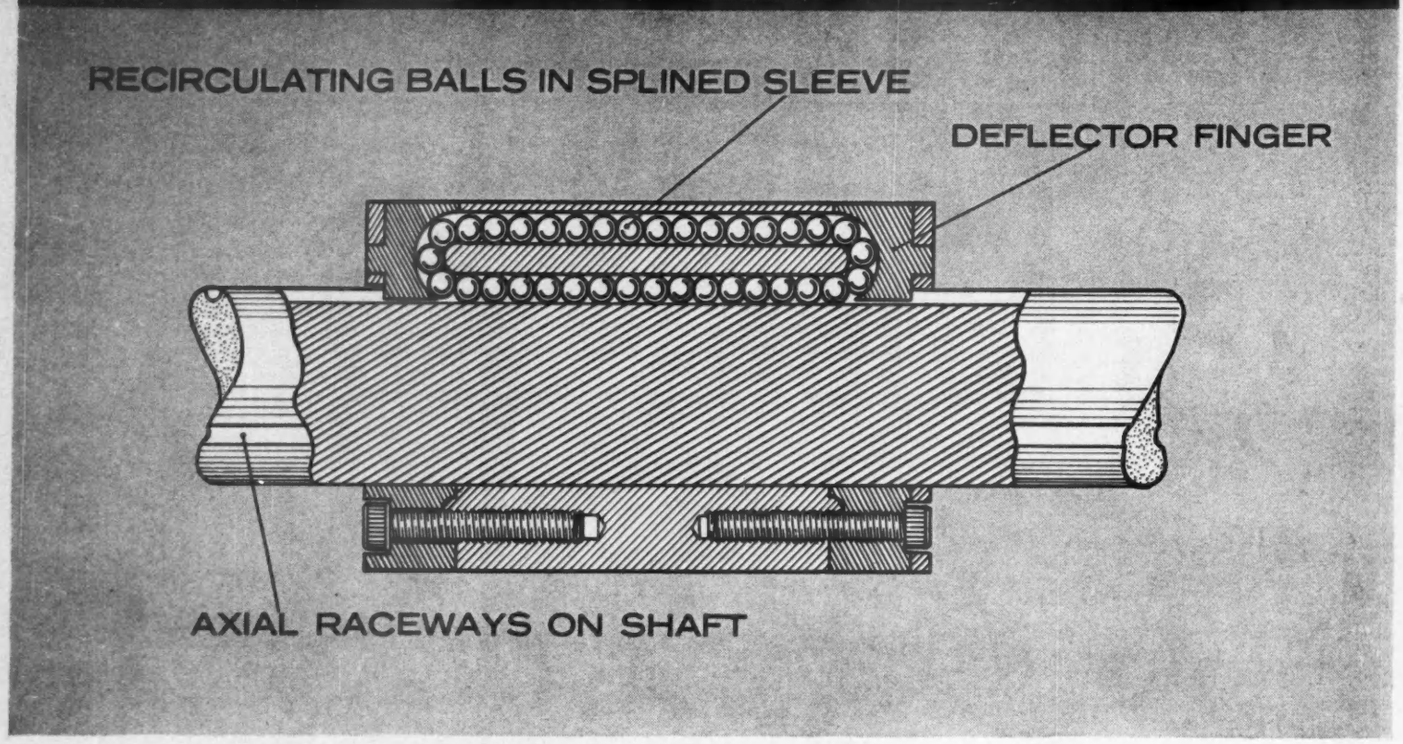

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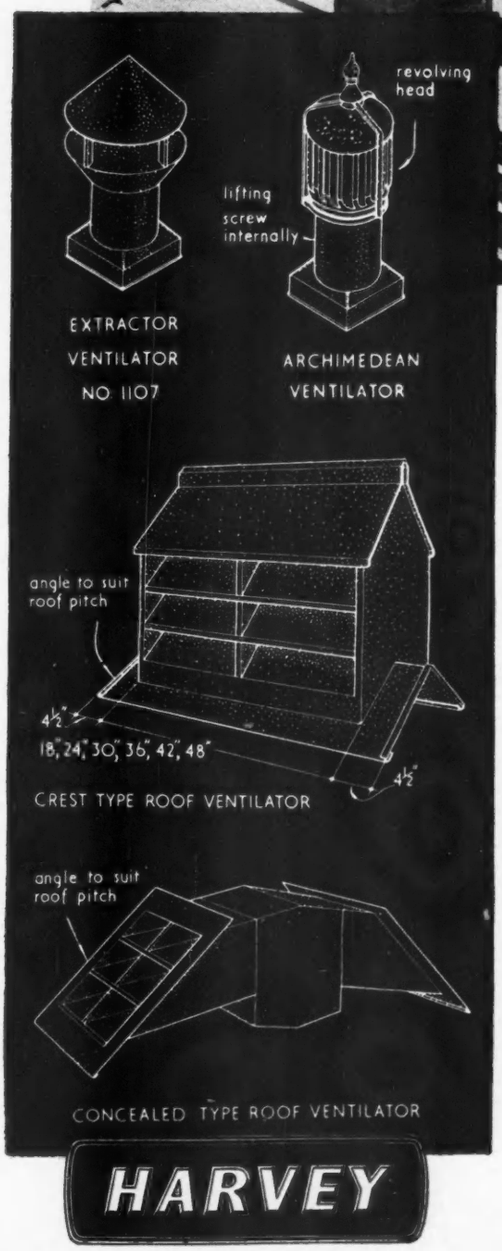

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